REMEDIAL INVESTIGATION AND FEASIBILITY STUDY PLANS FOR LOW PRIORITY SITES

VOLUME II

APPENDICES A THROUGH M

SAMPLING PLANS, FEASIBILITY STUDY/RISK ASSESSMENT PLANS

U.S. DEPARTMENT OF ENERGY
ROCKY FLATS PLANT
GOLDEN, COLORADO

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ROCKWELL INTERNATIONAL
AEROSPACE OPERATIONS
ROCKY FLATS PLANT

DRAFT

REVIEWED FOR CLASSIFICATION
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LIST OF APPENDICES

INTRODUCTION

Appendices A through K are sampling plans for SWMU Groups A through K. Table A-1 lists the SWMUs in each group. Figures showing the SWMUs within each SWMU Group are found at the end of the appropriate appendix. The investigative and administrative techniques required to execute the sampling plans are included in the Quality Assurance Project Plan developed for the low priority SWMUs and found in Appendix M. The safety procedures to be followed in conducting field investigations are specified in the Health and Safety Plan (Appendix N).

APPENDIX A

SWMU GROUP A
SWMUs 142.1, 142.2, 142.3, & 142.4
SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP A CHARACTERISTICS

1.1 DESCRIPTION

SWMU Group A (Figure A-1) consists of the four A-series retention ponds (SWMUs 142.1 through 142.4). These ponds are located in North Walnut Creek drainage. From the beginning of operations at the Rocky Flats Plant until approximately 1974, the only pond on North Walnut Creek was A-1 (SWMU 142.1).

Ponds A-1 and A-2 were used in the past to hold various types of waste substances. Presently, these two ponds are used only for spill control.

Pond A-3 receives flow from North Walnut Creek and runoff from the northern portion of the Plant site. Pond A-4 is used for surface water control and additional storage capacity for overflow from pond A-3. The NPDES discharge permit requires the monitoring of specific parameters at discharge sites located at Ponds A-3 and A-4. Limitations for nitrate and pH are placed on Pond A-3 discharges and Pond A-4 has sediment release limitations. In addition to these parameters, both discharge sites are monitored for plutonium, uranium, americium and tritium.

The North Walnut Creek drainage and the associated A-series ponds are located northeast of the Plant site. The final discharge from Pond A-4 is released into Walnut Creek which empties into the Great Western Reservoir approximately 1-1/2 miles downstream of Pond A-4. The Great Western Reservoir supplies the municipal drinking water for the City of Broomfield.

1.2 SOURCE CHARACTERIZATION

Pond A-1 was used to hold various wastes that contained plutonium, uranium and nitrates. There is evidence that a significant amount of plutonium was released from stream sediments into Pond A-1 during pond reconstruction activities from 1971 to 1973.

Ponds A-1 and A-2 were used to hold various hazardous wastes from 1974 to 1979. Pond A-2 received process wastewater and laundry wastewater pumped from Pond B-2, which received hazardous wastes prior to 1979.

The RCRA Part B Permit (DOE, 1986) indicates that water in Ponds A-1, A-2, and A-3 contained plutonium and uranium in elevated concentrations. Water from Ponds A-1 and A-2 also contained zinc at elevated concentrations. Water from A-3 contained significant amounts of manganese and strontium. Water quality in Pond A-4 was typical of upgradient background conditions.

1.3 POTENTIAL PATHWAYS

Contamination in the water or the sediments of the A-series ponds could migrate via North Walnut Creek or through the groundwater system of the stream valley colluvium. These ponds are not lined, making it possible for contaminants to enter the underlying stream and valley colluvium.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purpose of the investigation of the A-series ponds is:

1) to determine the concentration and extent of any contamination present in the surface water and pond sediments (Source Characterization)

2) to determine if contaminants are migrating via the surface water or groundwater pathways (Pathway Characterization)

The investigations will consists of two major tasks. Task 1 concentrates on gathering all existing background data to ensure that additional tasks are optimized and that a clear understanding of the problems is obtained. Task 2 consists of field investigation subtasks to characterize the sources and pathways. All investigations will follow the procedures in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1-COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. This task will include, but is not limited to, the following components.

2.2.1 Collection and Analysis of Existing Data

Surface Water and Sediment-All water quality and sediment sampling data will be obtained and evaluated. Water quality data on available DOE (1986a), the annual environmental monitoring reports, and other monitoring programs. Sediment data are available in DOE (1980) and DOE (1986a). These data and any additional data will be thoroughly evaluated before initiation of field activities.

Groundwater-At the present, there are numerous groundwater monitoring wells upgradient from the A-1 pond (13-86, 14-86, 15-86, 16-86, and 17-86). There is one well upgradient from the A-3 pond and downgradient from the A-2 pond (Well 12-86). Downgradient from pond A-4 there are three relatively recent well installations (1-81, 11-86 and 38-86). Groundwater monitoring data from these wells will be evaluated to determine if groundwater contamination plumes are present, and if contaminant concentrations are increasing or decreasing.

2.2.2 Historical Operational Procedures

All information available from Plant files or from interviews from people involved with the construction and operation of the A-series ponds will be reviewed for site-specific data pertaining to site history, past waste discharges, release incidents and any other pertinent information.

2.2.3 Other Sources

Any information uncovered during the course of other Task 1 activities which includes additional data pertinent to the investigation will be considered before field activities commence.

2.3 TASK 2-FIELD INVESTIGATIONS

Some information is currently available to evaluate both the sources (ponds) and pathways (groundwater and surface water). The data gaps identified at this time are for sediments and groundwater quality information. This plan concentrates on obtaining sediment data and determining if migration of contaminants via groundwater is present. Additional field activities may be required, based on findings during Task 1.

2.3.1 Task 2.1-Surface Water and Sediment Sampling

Seven surface water and sediment samples will be taken from the A-1 pond because of its past history of waste management. Three sediment and surface water samples will be taken from each of ponds A-2, A-3, and A-4. Additional surface water and sediment samples will be collected upstream and downstream of each pond for correlation between the routine Plant surface water monitoring program and the proposed sampling program. The upstream and downstream sampling points will correspond to locations that are currently sampled during routine monitoring activities. The samples will be analyzed for selected hazardous substance list and radioactive elements (plutonium, uranium, americium, and tritium).

The combination of surface water and sediment samples at a single location will help determine the relationship between contaminants in the sediment and contaminants that are released to the surface water.

2.3.2 Task 2.2-Groundwater Investigation

Additional downgradient wells are needed to monitor groundwater quality in the vicinity of the ponds. There appear to be sufficient wells upgradient of the A-1 pond. A new alluvial monitor well will be installed downgradient of Pond A-2 if access to the existing well (12-86) continues to be a problem. The replacement well location will be directed by data obtained in Task 2.3.

Well 11-86, will be used to monitor the groundwater affected by SWMU 142.4 (Pond A-4). A new alluvial well will be installed in this area if indicated by Task 2.3 data.

Pond A-1, SWMU 142.1, has received the greatest amount of wastes. Presently, there is not a monitor well downgradient of this pond to monitor any possible releases from it. An alluvial monitor well will be installed downgradient that will also act as an upgradient monitoring well for SWMU 142.2, Pond A-2.

In summary, three or possibly four shallow alluvial monitor wells will be constructed in the locations indicated in Figure A-1. The locations and rational for these wells are as follows:

- Location A - Groundwater quality downgradient of Pond A-1 will be monitored at this location.

- Location B - If access to well 12-86 continues to be a problem, a replacement well will be installed to monitor groundwater quality downgradient of the pond.

- Location C - A monitor well may be installed to augment the water quality data in this area.

- Location D - A monitor well will be installed between ponds A-3 and A-4 to monitor conditions of A-3 and upgradient of A-4.

All wells will be constructed in such a way as to efficiently monitor the groundwater independent of any water table fluctuations caused by seasonal changes. Upon completion of the monitor well, slug tests will be performed to obtain aquifer information.

Groundwater samples will be collected and analyzed quarterly for one year. If contaminants are detected, a regular monitoring program will be developed in the next phase of this investigation.

2.3.3 Task 2.3 Geophysical Survey

A resistivity or electromagnetic survey will be conducted in the area surrounding any existing dry wells in order to locate the shallow groundwater path should it be present as a thin buried channel. Then data will be used to locate additional monitor wells.

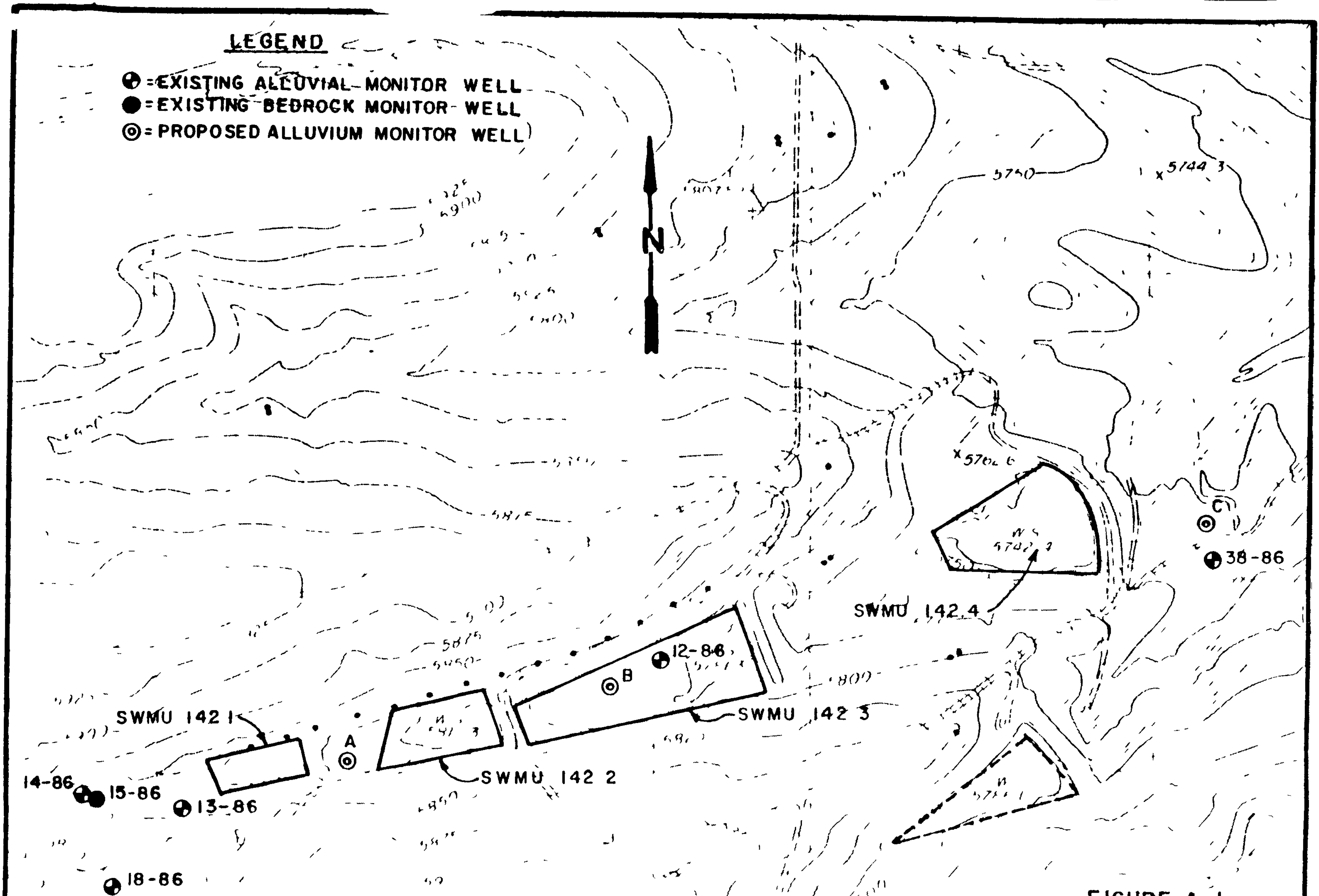

FIGURE A-1
MAP OF SWMU
GROUP A
Scale 1"=500'

APPENDIX B

SWMU GROUP B
SWMUs 141, 142.5, 142.6, 142.7, 142.8, 142.9 and 156.2
SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP B CHARACTERISTICS

1.1 DESCRIPTION

Group B (Figure B-1) consists of the Rocky Flats Plant B-series retention ponds (SWMUs 142.5 through 142.9), the sludge dispersal site (SWMU 141), and the contaminated soil dump area (SWMU 156.2). These SWMUs are located east of the security-fenced area in the South Woman Creek drainage area.

Ponds B-1 through B-4 (SWMUs 142.5 through 142.8), located on South Walnut Creek, were used to hold various wastes that contained nitrate, plutonium and uranium. Ponds B-1 and B-2 are reserved for spill control. Ponds B-1, B-3, and B-4 receive effluent from the sanitary sewage treatment plant. Ponds B-4 and B-5 receive surface runoff from the central part of the Plant site. Discharges from Ponds B-3 and B-5 are in accordance with the Plant NPDES permit, including monitoring for plutonium, americium, uranium, and tritium.

Sludge from the sewage treatment plant was collected in drying beds west of the B-series ponds, where it was dried, and shipped off-site for disposal as a radioactive waste. Some of the dried sludge became airborne and formed SWMU 141.

Soil contaminated with low levels of plutonium from around Building 774 were placed northwest of the B-series ponds to form SWMU 156.2. Asphalt and concrete have been dumped in the north and south areas of the site.

1.2 SOURCE CHARACTERIZATION

The soils at SWMUs 141 and 156.2 may be contaminated with plutonium. The volumes of hazardous constituents are unknown. SWMUs 142.5 through 142.9 may contain various wastes including nitrates, plutonium and uranium. Analyses of water from Ponds B-1, B-4, and B-5 indicated above background levels of U^{233}, U^{234}, and U^{238}. In addition, trichloroethane was detected in B-4. Plutonium has been detected in water from B-2 and nitrates were detected in B-3. Plutonium has been detected in the sediments of the B-Series Ponds.

1.3 POTENTIAL PATHWAYS

Fugitive dust from SWMUs 141 and 156.2 may allow exposure to humans and the environment along the air pathway. The air pathway is negligible for the retention ponds as long as water prevents the sediments from being exposed and drying.

Surface water contamination from SWMUs 141 and 156.2 would contribute to contaminant levels in the A-series and B-series ponds and will be investigated with the ponds. SWMUs 142.5 through 142.9 (the B-series ponds) may release contaminants to Walnut Creek which discharges into the Great Western Reservoir, the water supply for the community of Broomfield.

Groundwater contamination is possible from all of these SWMUs. Surface water infiltration through contaminated soils or sediment may pick up contaminants and carry them to the groundwater.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purposes of investigations of these SWMUs are as follows:

1) determine if soils in the sludge dispersal area (SWMU 141) and the soil dump area (SWMU 156.2) are contaminated (Source Characterization)

2) determine if surface water and sediment in the B-series ponds are contaminated (Source Contamination)

3) determine if contaminants are being released to the groundwater (Pathway Characterization)

4) determine whether or not contaminants are being released to the surface water and sediment downstream of the B-series ponds (Pathway Characterization)

The investigations will consist of two major tasks. Task 1 concentrates on gathering all existing background data to ensure that additional tasks are optimize and that a clear understanding of the problems is obtained. Task 2 consists of field investigation subtasks to characterize the sources and pathways. All investigations will follow the procedures in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1-COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan.

This task will include, but is not limited to, the components described below.

It is not expected that there are utilities in this area which would affect the field investigations.

2.2.1 Collection and Analysis of Existing Data

Surface Water and Sediment-All analytical data from the surface water and sediment sampling along South Walnut Creek data will be evaluated.

Groundwater-There are monitor wells along South Walnut Creek upgradient and downgradient of the retention ponds. Data from these wells will be evaluated to determine the hydrogeology of the area. Water quality data, particularly from monitor wells 37-86 and 38-86, will be evaluated to see if they give any indication of the influence of the retention ponds on groundwater quality. Monitor well 36-86 will be evaluated with monitor well 35-86 to determine if they can be used to evaluate the contribution of SWMU 141 to groundwater quality.

2.2.2 Historical Operational Procedures

All information available from Plant files or from interviews of people involved with the construction and operation of the ponds and sludge drying beds will be reviewed for site-specific data pertaining to site history, past waste disposal practices, release incidents and any other pertinent information.

2.2.3 Other Sources

Any information uncovered during the course of other Task 1 activities which includes additional data pertinent to the investigation will be considered before field activities commence.

2.3 TASK 2-FIELD INVESTIGATIONS

The investigations planned for Task 2 are based on information available at this time. Modifications to the field activities may be required, based on findings during Task 1 and Task 2.

2.3.1 Task 2.1-Radiological Survey

A radiological survey will be performed at SWMUs 141 and 156.2 to determine if radiation is being released to the atmosphere. Readings will initially be taken on a 20-foot grid using a shielded pancake Geiger-Mueller (G-M) detector and side-shielded field instrument for detecting low energy radiation (FIDLER). If significant hot spots are detected, the grid in that area will be tightened to 5-feet on center and a set of FIDLER and G-M detector readings will be taken within six inches of the surface. The results will be plotted on a map and contoured.

2.3.2 Task 2.2-Surface Soil Sampling

Soils from SWMUs 141 and 156.2 will be sampled to determine if they are potential sources of radiological and chemical contamination. The number of samples and sample locations will be selected based on the results of the radiological survey. Locations with above background radiation readings will be sampled at the surface. At locations where the 12-inch-deep detector readings were also above average, soil samples will be taken at 12 and 24 inches below the surface. The samples will be screened using the pancake G-M detector and side-shielded FIDLER. If elevated readings are detected, boreholes will be drilled at selected locations to an approximate depth of 10 feet. The soil will be sampled at one-foot intervals and screened with the detectors. Selected soil samples (no more than 50% of those collected) will be analyzed for Pu^{239}, Am^{241}, and $U^{234, 235, 238}$ by alpha spectroscopy, as needed. This procedure will define the limit, depth, volume and concentration of contamination.

2.3.3 Task 2.3-Surface Water and Sediment Sampling

Surface water and sediment samples will be taken from three locations in each of the Ponds B-1 through B-4 and five locations in Pond B-5. Surface water and sediment samples will also be taken between Ponds B-4 and B-5 and downstream of Pond B-5. If there are locations which are currently sampled during routine monitoring activities near these sampling points, the samples will be taken from normal sampling points. The samples will be analyzed for selected constituents on the Hazardous Substance List plus radioactive elements (plutonium, uranium, americium, and tritium). The surface water and sediment samples will collected at the same times and locations in order to correlate surface water and sediment analytical results.

2.3.4 Task 2.4-Groundwater Investigation

There are three monitor wells in the vicinity of these SWMUs which could be monitoring groundwater that is affected by these SWMUs. During the fourth quarter of 1987 these wells were dry, indicating that the alluvium is un-saturated or that there is a very thin buried alluvial channel in which the groundwater is flowing. A geophysical survey of the drainage (Task 2.5) will be performed to evaluate the geometry of the bottom of the alluvium. If a saturated channel is indicated, four shallow monitor wells will be constructed in the locations indicated in Figure B-1 if this is found to be the situation. The locations for these wells were selected for the following reasons:

- Location A will monitor water quality upgradient of the ponds and downgradient of all potential contaminant sources at the Plant.

- Location B will monitor water quality downgradient of Pond B-1, which may have received the most contaminants of the five ponds.

- Location C will monitor water quality downgradient of the first four ponds.

- Location D will monitor water quality downgradient of the B-series ponds, before the groundwater is affected by any contaminants from the A-series ponds.

Information gathered during the radiation surveys and surface soil sampling at SWMUs 141 and 156.2 may necessitate the installation of one or more wells at each of these SWMUs.

All of the wells will be constructed so that the saturated portion of the aquifer is completely screened according to the specifications in the Low Priority SWMU QAPP. Upon well completion, slug tests will be conducted in all wells to obtain aquifer hydrologic information. Groundwater samples will be collected and analyzed quarterly for one year.

2.3.5 Task 2.5-Geophysical Survey

A resistivity or electromagnetic survey will be conducted in the area surrounding the dry wells in order to locate the shallow groundwater path should it be present as a thin buried channel. Then data will be used to locate additional monitor wells.

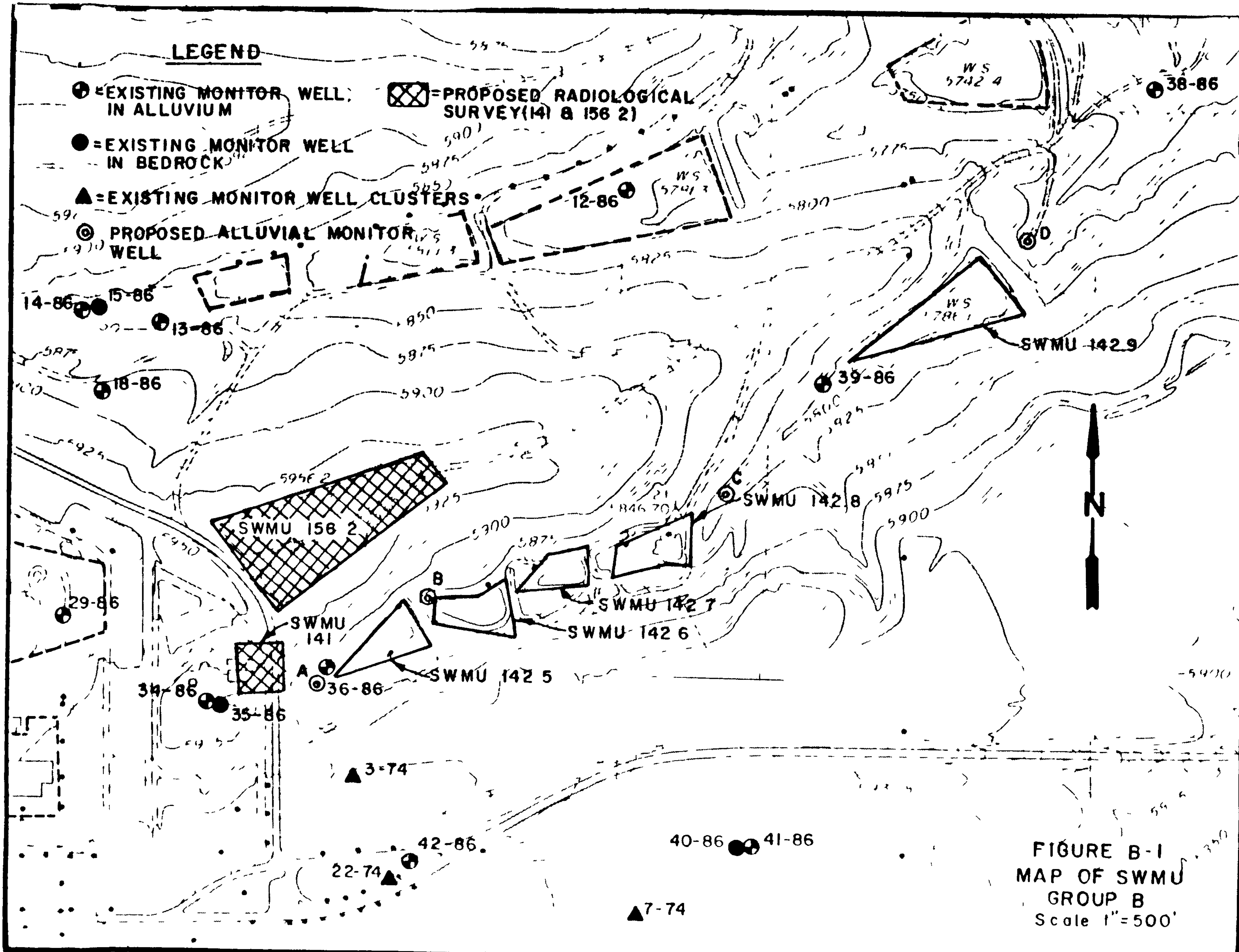

FIGURE B-1
MAP OF SWMU
GROUP B
Scale 1"=500'

APPENDIX C

SWMU GROUP C

SWMUs 142.10 and 142.11

SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP C CHARACTERISTICS

1.1 DESCRIPTION

Group C (Figure C-1) consists of the Rocky Flats Plant C-series retention ponds, C-1 (SWMU 142.10) and C-2 (SWMU 142.11). The retention ponds are used primarily to capture and control surface water runoff and to allow sampling and analysis prior to reuse or release of the water downstream.

The C-series ponds are located on Woman Creek, southeast of the Plant. Woman Creek enters Standley Lake about 2 miles downstream of Pond C-2. Standley Lake provides municipal water supply for the Cities of Westminster, Thornton and Northglenn (DOE 1986a).

1.2 SOURCE CHARACTERIZATION

Pond C-1 receives stream flow from Woman Creek. Prior to 1979, this pond was used to hold various wastes that contained nitrates, plutonium, and uranium.

Pond C-2, which was constructed after 1979, receives surface runoff from the South Interceptor Ditch, the drainage collector for the southern portion of the Plant site. Flow from Woman Creek is diverted around Pond C-2.

Water from pond C-2 is periodically discharged under the NPDES permit and DOE radioactive limits in effect at the time. Sediment release limitations have been established for C-2. In addition the discharge is monitored for plutonium, americium, uranium, and tritium.

Both ponds have downstream 24-hour time-composited samplers and Parshall flumes to monitor discharge. Continuous flow measurements and daily water quality samples are collected at these sites. Woman Creek is grab-sampled monthly above Pond C-1.

1.3 POTENTIAL PATHWAYS

Any contamination in the water or sediment of the C-series ponds could travel from the ponds through the surface water or groundwater pathways. As mentioned above, surface water is discharged periodically. Neither pond is lined and they are constructed in the permeable Woman Creek alluvium, indicating a potential for groundwater contamination.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purposes of investigations of these SWMUs are:

1) to define whether or not any contamination exists in the surface water and sediment (Source Characterization)

2) to determine if contaminants are being released to the surface water or groundwater (Pathway Characterization)

The investigations will consist of two major tasks. Task 1 concentrates on gathering all existing background data to ensure that additional tasks are optimized and that a clear understanding of the problems is obtained. Task 2 consists of field investigation subtasks to characterize the source and pathways. All investigations will follow the procedures in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1- COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. This task will include, but is not limited to, the components described below.

2.2.1 Collection and Analysis of Existing Data

Surface Water and Sediment-The analytical data from the surface water and sediment sampling of the C-series ponds will be collected and evaluated.

Groundwater-Maps along Woman Creek indicate that there are monitor wells upgradient and downgradient from each pond. Data from the wells along the Creek and from the current 903 area investigation will give insight to the hydrogeology in the area. Water quality data, particularly from monitor wells 64-86, 65-86 and 66-86, will be evaluated to determine the influence of the ponds on groundwater quality.

2.2.2 Historical Operational Procedures

All information available from Plant files or from interviews of people involved with the construction and operation of the C-series ponds will be reviewed for site-specific data pertaining to site history, past waste discharges, release incidents and any other pertinent information.

2.2.3 Other Sources

Any information uncovered during the course of other Task 1 activities which includes additional data pertinent to the investigation will be considered before field activities commence.

2.3 TASK 2- FIELD INVESTIGATIONS

A great deal of information is available to evaluate both the sources (ponds) and pathways (groundwater and surface water). The only obvious data gap at this time is for sediments. This plan concentrates on gathering sediment data. Additional field activities may be required based on findings during Task 1.

2.3.1 Task 2.1-Surface Water and Sediment Sampling

Three sediment and surface water samples will be taken from each pond to establish if the ponds are a source of contamination. Additional surface water and sediment samples will be taken upstream and downstream of each pond to evaluate if contaminants are still being transported to the ponds and if contaminants are being released from the ponds. The upstream and downstream sampling points will correspond to locations that are currently sampled during routine monitoring activities. The samples will be analyzed for all Hazardous Substance List constituents and for radioactive elements (uranium, plutonium, americium, and tritium).

The surface water samples are being taken to establish the relationship between contaminants in the sediment and contaminants that are released to the surface water.

2.3.2 Additional Investigation

Additional investigations which may be required based on the findings of Task 1 and the Surface Water and Sediment Sampling are:

1) Installation and sampling of additional shallow monitor wells,

2) Installation and sampling of deeper monitor wells, and

3) Sampling of aquatic life downstream of the ponds.

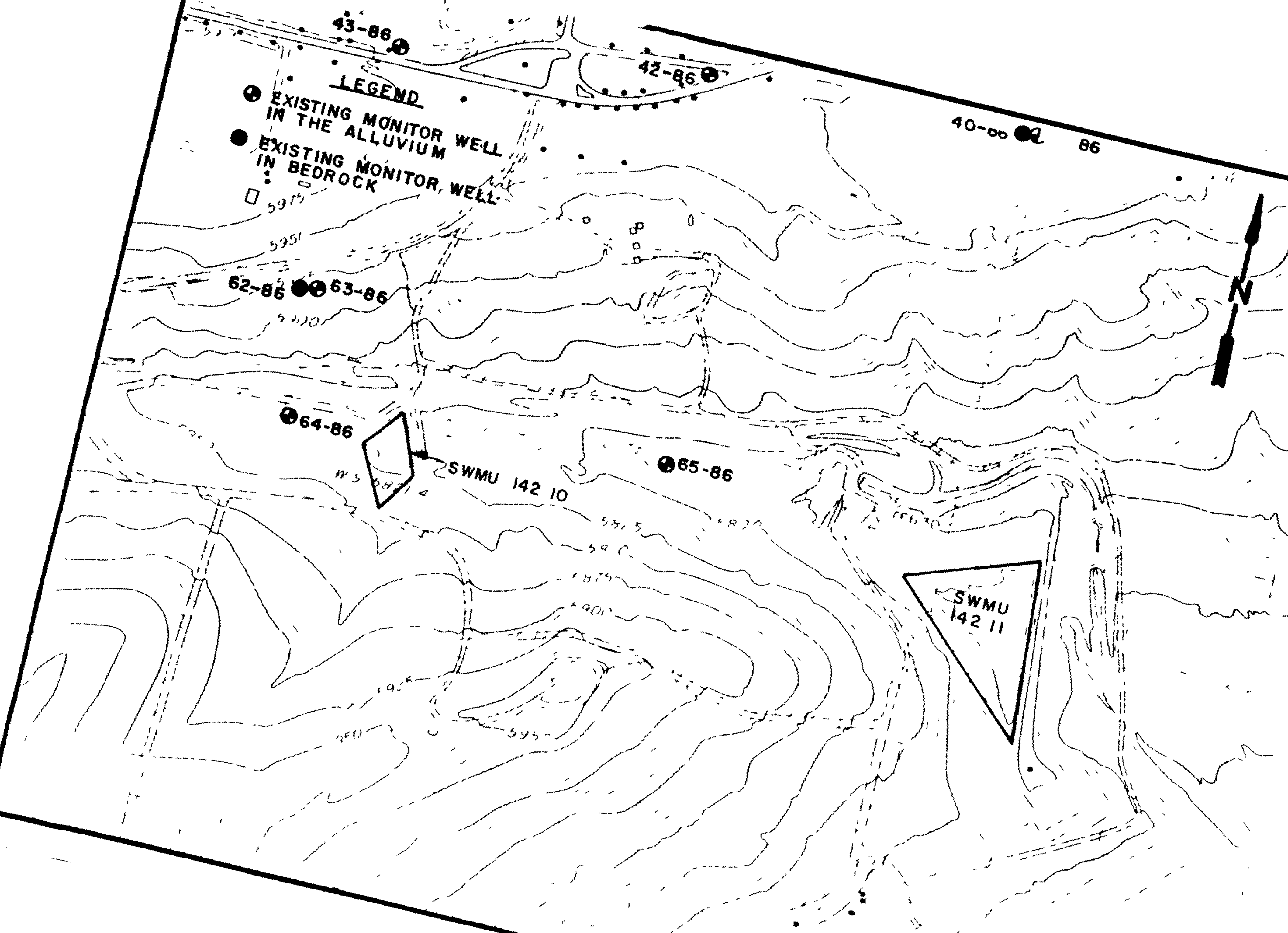

FIGURE C-1
MAP OF SWMU
GROUP

APPENDIX D

SWMU GROUP D
SWMUs 115 and 133
SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP D CHARACTERISTICS

1.1 DESCRIPTION

Group D (Figure D-1) consists of the original Rocky Flats Plant landfill (SWMU 115) and the ash pits (SWMUs 133.1 through 133.6). These SWMUs are located south to southwest of the security-fenced area and north of Woman Creek. They were in use from about 1952 to 1968.

1.2 SOURCE CHARACTERIZATION

An estimated 20 kilograms of depleted uranium is buried in the landfill with approximately 2 million cubic feet of miscellaneous plant wastes. The general plant wastes are expected to consist primarily of paper trash and construction debris but may also include solvents, paint, paint thinners, oil, pesticides, cleaners and other materials that were not considered hazardous at the time of the landfill operation.

The ash in the pits were generated by an incinerator (SWMU 133.5) used to burn general combustible waste. CEARP Phase I (DOE, 1986a) indicates that approximately 100 grams of depleted uranium chips were also burned in the incinerator during its use.

1.3 POTENTIAL PATHWAYS

The covers of the ash pits and the landfill, if they remain intact, prevent air and direct surface water contamination and exposure by direct contact. Contamination of both surface water and groundwater is possible through the groundwater pathway. Surface water infiltrating these SWMUs or groundwater passing through them may pick up contaminants that could be discharged to

Woman Creek, the South Diversion Ditch, or continue migration in the groundwater system.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purposes of investigations of these SWMUs are as follows:

1) determine the precise location, the dimensions and the contents of the ash pits (Source Characterization)

2) determine if contaminants are being released to the groundwater (Pathway Characterization)

3) determine whether or not contaminants are being released to the surface water and sediment (Pathway Characterization)

The investigations will consist of two major tasks. Task 1 concentrates on gathering all existing background data to ensure that additional tasks are optimized and that a clear understanding of the problem is obtained. Task 2 consists of field investigation subtasks to characterize the sources and pathways. All investigations will follow the procedures in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1-COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. It is not expected that there are utilities in this area which would affect the field investigations. This task will include, but is not limited to, the components described below.

2.2.1 Collection and Analysis of Existing Data

Surface Water and Sediment-The analytical data from the surface water and sediment sampling along Woman Creek will be collected and evaluated.

Groundwater-There are several monitor wells along Woman Creek upstream and downstream of the landfill and ash pits. Data from these wells will be evaluated to characterize the hydrogeologic setting of the SWMUs. Water quality data, particularly from monitor wells 57-86, 4-81 and 70-86, will be evaluated to see if they indicate an influence of the landfill on groundwater quality.

2.2.2 Historical Operational Procedures

All information available from Plant files or from interviews from people involved with the construction and operation of the landfill and ash pits will be reviewed for site-specific data pertaining to site history, past waste disposal practices, release incidents and any other pertinent information.

2.2.3 Other Sources

Any information uncovered during the course of other Task 1 activities which includes additional data pertinent to the investigation will be considered before field activities commence.

2.3 TASK 2-FIELD INVESTIGATIONS

The investigations planned for Task 2 are based on information available at this time. Modifications to the field activities may be warranted based on findings during Tasks 1 and 2.

2.3.1 Task 2.1-Radiological Survey

A radiological survey will be performed over the area of the ash pits to determine if radiation is being released through the cover material. The survey will be performed using a side-shielded field instrument for detection of low energy radiation (FIDLER) and a shielded Geiger-Mueller (G-M) pancake detector. Readings will initially be taken on a 20-foot grid. If significant hot spots are detected, the grid in that area will be tightened to 5 feet on center. The results will be plotted on a map and contoured.

2.3.2 Task 2.2-Ash Pit Sampling

The ash pits will be sampled to determine if they are potential sources of radiological and chemical contamination. Samples will be taken from three locations in each of the six ash pits. The sample locations will be selected based on the results of the radiological survey.

The samples, if possible, will be taken using hand augers or portable power augers to drill through the cover and ash pits and into the underlying soil. The samples will be taken every 2 feet to a depth of at least 5 feet below the bottom of the ash pit. The bottom of the ash pit will be determined by observation of recovered material.

The soil samples will be screened using a shielded pancake G-M detector and a side-shielded FIDLER. The samples will be analyzed for radioactive elements (uranium, plutonium, americium, and tritium) and CLP task 1 and task 2 inorganics.

2.3.3 Task 2.3-Groundwater Investigation

Two upgradient and two downgradient monitor wells will be constructed at the locations indicated in Figure D-1 to specifically evaluate groundwater conditions near the landfill. Information gathered in Task 1 may necessitate a modification in the location or number of wells required.

If the results of Task 2.2 (Ash Pit Sampling) indicate that the ash pits are a source of contaminants, two or three downgradient wells will be installed. Existing wells (48-86 and 49-86) will be used to characterize conditions upgradient of the ash pits.

All of the wells will be constructed according to the specifications in the Low Priority SWMU QAPP. Slug tests will be conducted upon well completion.

Groundwater samples will be collected for analysis quarterly for one year. Water recovered from the wells will be analyzed for all Hazardous Substance List organics and metal constituents and radioactive elements (Pu^{238}, ^{232}, ^{240}, Am^{241}, U^{234}, ^{235}, ^{238}).

2.3.4 Task 2.4-Surface Water and Sediment Sampling

Surface water and sediment samples will be taken upstream and downstream of the pits and the landfill. The samples will be taken in Woman Creek and the South Interceptor Ditch. If there are locations which are currently sampled during routine monitoring activities near anticipated sampling points, the samples will be taken from normal sampling points.

The surface water samples are being taken to establish the relationship between contaminants in the sediment and contaminants that are released to the surface water. The samples will be analyzed for all Hazardous Substance List organics and metal constituents and radioactive elements (uranium, plutonium, americium, and tritium).

2.3.5 Task 2.5-Geophysical Investigation

If Task 2.1 (Ash Pit Sampling) indicates that the ash pits are a source of contamination, a ground-penetrating radar, electromagnetic conductivity or resistivity survey may be necessary to precisely delineate each pit boundary.

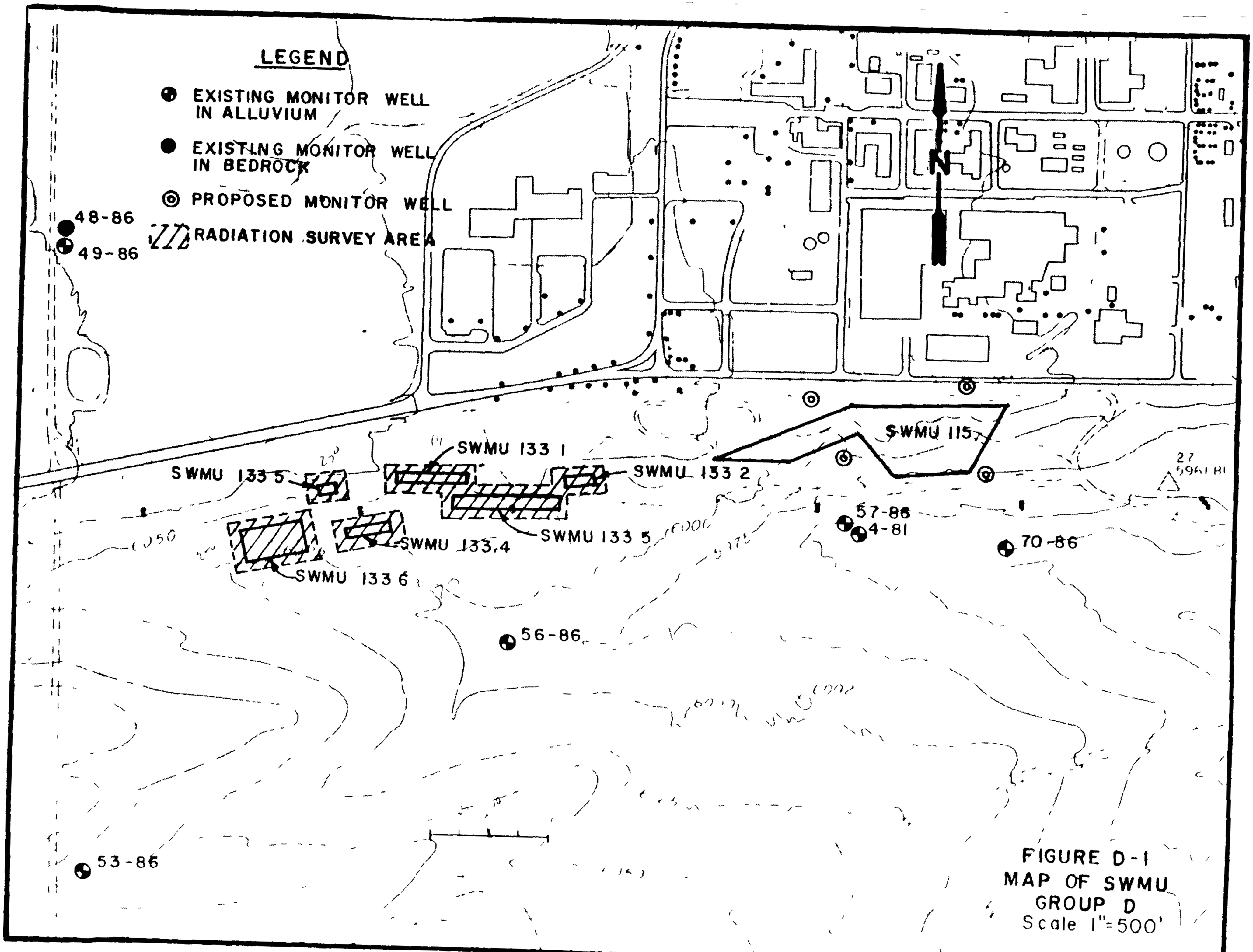

FIGURE D-1
MAP OF SWMU
GROUP D
Scale 1"=500'

APPENDIX E

SWMU GROUP E
SWMUs 117.2, 118, 120
SAMPLING PLAN

1.0 SUMMARY OF GROUP E CHARACTERISTICS

1.1 DESCRIPTION

Group E consists SWMUs within the fenced security area containing chemical spills. This includes the following SWMUs:

- 117.2, 118.2, 120 Unidentified Solvent Spills
- 118.1 Carbon Tetrachloride and Trichloroethylene Spill

1.2 SOURCE CHARACTERIZATION

Contamination at from SWMU 118.1 resulting from carbon tetrachloride spills associated with filling operations of a 5000-gallon, below-grade tank, and a 100- to 200-gallon spill of trichloroethylene (possibly carbon tetrachloride) in the area.

The exact contaminants at SWMUs 117.2, 118.2 and 120 are unknown. Further investigation will be performed to identify the actual solvents, but it is likely that the spills involved some of the solvents commonly used at Rocky Flats: carbon tetrachloride, trichloroethylene, perchloroethylene, 1,1,1-trichloroethane, methyl ethyl ketone, petroleum distillates, paint thinners (typically benzene and dichloromethane) and styrene. All of these spills occurred on unpaved areas, except for SWMU 120, which may have been paved at the time of the spills. Most of these SWMUs are at least partially paved now.

1.3 POTENTIAL PATHWAYS

Surface water is not considered a pathway since all surface water flows to the retention ponds are evaluated as SWMU 142.

The air pathway is negligible since these spills would have already volatilized or travelled through the soil.

The primary pathway is through groundwater. Most of the solvents likely to have been spilled at these sites are highly mobile through soil.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purposes of investigation of these SWMUs are as follows:

1) Determine whether or not contamination exists in the soil (Source Characterization)
2) Determine if contaminants are being or have been released to the groundwater (Pathway Characterization)

The investigation will consist of two major tasks. Task 1 is to gather all existing background information, particularly to identify what solvents were likely to have been spilled. Task 2 consists of field investigations to characterize the source and pathways. All investigations will follow the procedures in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1-COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. The main goal of these investigations will be to identify specific solvents and quantities likely to have been spilled, and their locations. This task includes the components described below.

2.2.1 <u>Personnel Interviews</u>

Personnel interviews conducted in the past will be reviewed for any information that may assist in determining the direction the field activities should take. Additional employee interviews will be performed to further characterize these SWMUs prior to field investigation.

2.2.2 Historic Operational Procedures and Remedial Actions

All information on historic operational procedures will be reviewed for site specific data to determine the quantities and types of solvents spilled and to further characterize cleanup efforts that were made. If necessary, purchasing files will be reviewed to determine all types of solvents that have been used at Rocky Flats Plant.

2.2.3 Utility Survey

A utility survey will be conducted prior to initiation of field activities to define any hazards presented to the field investigation crew by these utilities.

2.3 TASK 2-FIELD INVESTIGATIONS

The following work plan has been developed, based on available information. Modifications may be required if further background information indicates that this work has satisfactorily been completed, or for some reason is unnecessary.

The aerial radiological survey performed by EG&G in 1981 indicates the presence of an abnormally high radiation count in the vicinity of SWMU 120.2. As part of the investigation of SWMU 161 (part of Group H) a radiologic survey will be conducted over the area of SWMU 120.2. The data obtained from this investigation will also be evaluated to characterize SWMU 120.2. Refer to the Group H sample plans and Figure H-2 for details.

2.3.1 Task 2.1- Soils Investigation

Surface Soils-Samples will be collected at two-foot intervals to a depth of six feet at the tentative locations shown on Figure E-1. These samples will be analyzed for volatile organics.

Subsurface Soils-Samples will be taken at two-foot intervals as monitor wells are drilled at the locations shown in Figure E-1 and E-2. If more than six samples are taken prior to reaching groundwater, six samples will be analyzed immediately for volatile organic compounds (VOCs). The remainder may be held for seven days for additional analysis.

2.3.2 Task 2.2- Groundwater Investigation

Alluvial monitor wells will be installed at the locations shown on Figure E-1 and E-2. Wells will be drilled, sampled and completed according to specifications in the QAPP. Groundwater samples will be taken quarterly for one year. The samples will be analyzed for volatile organics and the full suite of HSL parameters. A slug test will be performed upon completion of each monitor well.

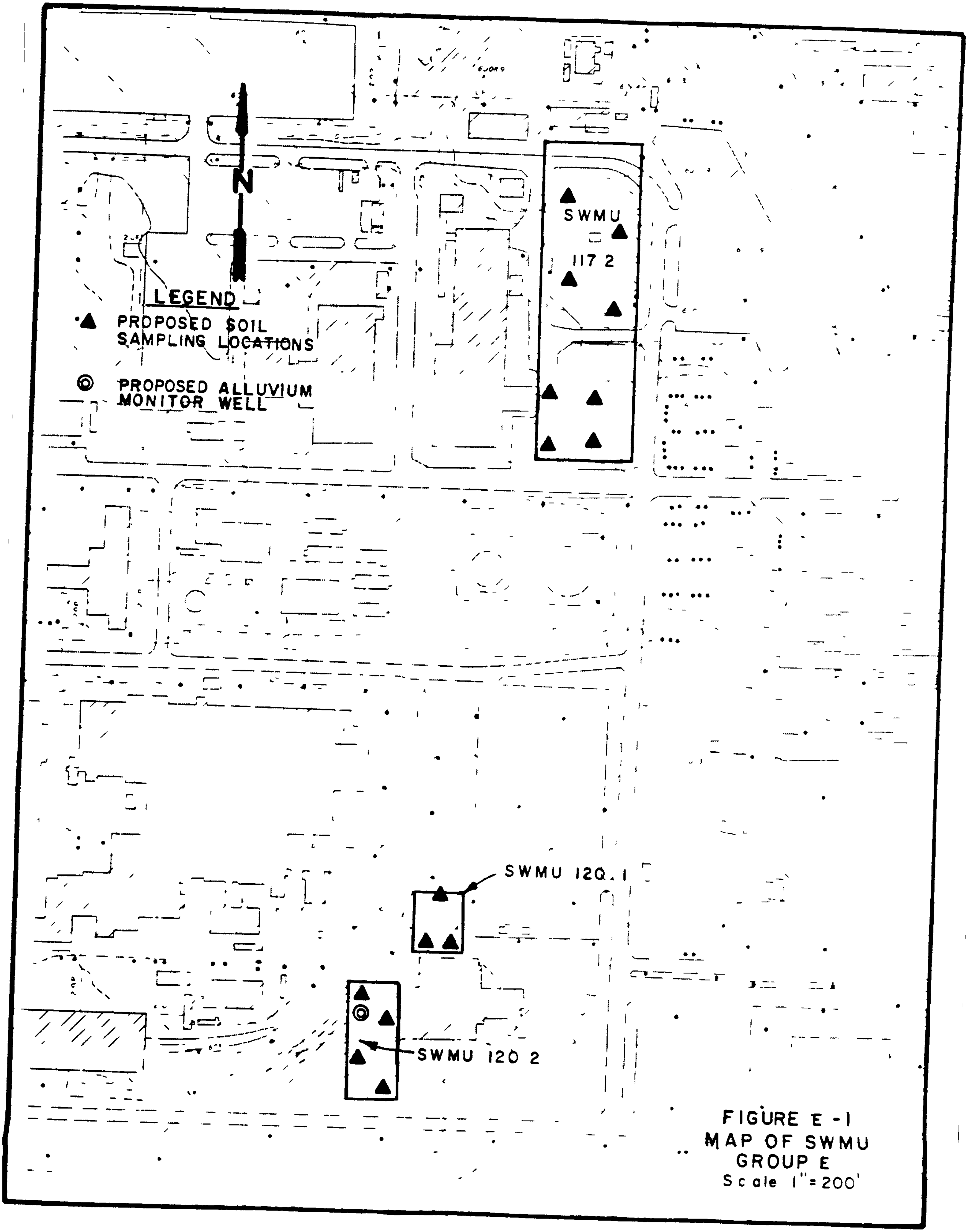

FIGURE E-1
MAP OF SWMU
GROUP E
Scale 1"=200'

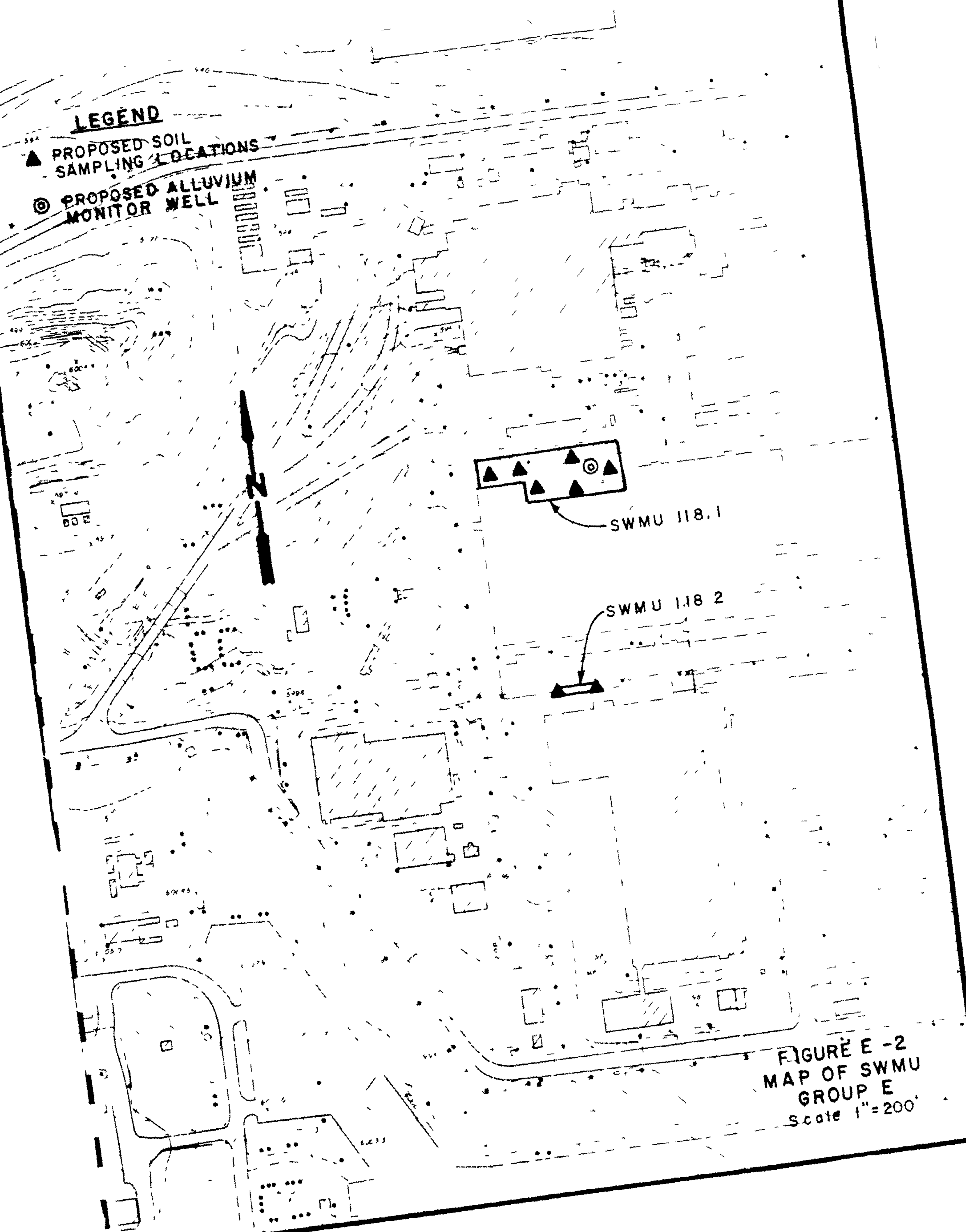

FIGURE E -2
MAP OF SWMU
GROUP E

APPENDIX F

SWMU GROUP F

SWMUs 166.1, 166.2, and 166.3

SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP F

1.1 DESCRIPTION

Group F consists of Trench A, Trench B, and Trench C denoted SWMUs 166.1, 166.2, and 166.3, respectively. These three trenches are located southeast of the present landfill (refer to Figure F-1 at the end of this appendix).

1.2 SOURCE CHARACTERIZATION

SWMUs 166.1 and 166.2 received uranium and plutonium contaminated sludge from Building 995, the sewage treatment plant.

The type of materials buried in SWMU 166.3 are unknown, but may have included sewage sludge containing small amounts of uranium and plutonium contamination.

1.3 POTENTIAL PATHWAYS

Surface disturbance of these SWMUs may result in fugitive dust subject to atmospheric transport.

Groundwater contamination is possible from all three of these SWMUs. Surface water infiltration through the contaminated soils may provide the mechanism for migration to and transport through the groundwater system.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purpose of the investigation of these SWMUs is to:

1) Characterize the types and concentrations of contaminants buried in the trenches (Source Characterization)

2) Determine if any contaminants are being released at the surface of the pits or to the groundwater (Pathway Characterization)

The sampling program will consist of two major tasks. Task 1 concentrates on gathering all existing background data to ensure that additional tasks are optimized. Task 2 consists of field investigation subtasks to characterize the source and pathways. All investigations will follow the procedures specified in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1-COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. This task will include, but is not limited to, the components described below.

2.2.1 Collection and Analysis of Existing Data

Information from monitor wells installed in 1987 will be obtained and evaluated to determine if additional wells are needed to accurately assess the impact of these SWMUs on groundwater quality.

2.2.2 Historical Operational Procedures

All information available from Plant files or from interviews of people involved with the construction and operation of the trenches will be reviewed for site-specific data pertaining to site history, past waste disposal practices, and any other pertinent information.

2.2.3 Other Sources

Any information uncovered during the course of other Task 1 activities which includes additional data pertinent to the investigation will be considered before field activities commence.

2.3 TASK 2-FIELD INVESTIGATIONS

The investigations planned for Task 2 are based on information available at the time of preparation of this sampling plan. Modifications to the field activities may be required, based on findings during Tasks 1 and 2.

2.3.1 Task 2.1-Geophysical Survey

Geophysical surveys will be conducted using ground penetrating radar, magnetometer or electromagnetic conductivity to define the boundaries of trenches and the possible presence of any buried drums or metal. The results of the geophysical survey will guide the soil sampling activities.

2.3.2 Task 2.2-Surface Soil Sampling

Soils from these SWMUs will be sampled to determine if they are potential sources of radiological and chemical contamination. Ten samples will be collected from SWMU 166.2, nine from SWMU

166.1, and eight from SWMU 166.3. Two samples will be taken at each location; one from a depth of 5 feet below the base of the trench, to determine if contaminants have migrated from the trenches, and one sample of the sludge within the trench. The samples will be analyzed for metals, inorganics, acid compounds, VOCs and radioactive elements; plutonium, uranium, tritium, and americium.

2.3.3 Task 2.3-Groundwater Investigation

If the trenches are determined to be potential contaminant sources, monitor wells will be installed in the alluvial aquifer to investigate conditions near the trenches. Soil samples will be collected at five-foot intervals for contaminant and geotechnical analyses. Upon completion of the well, a slug test will be performed to obtain hydrogeologic aquifer data.

Groundwater samples will be collected quarterly for one year for analysis. If contamination is detected, a long-range monitoring program will be established in the next phase of this investigation.

APPENDIX G

SWMU GROUP G
SWMUs 116, 128, 134, 136, and 157
SAMPLING PLAN

1.0 SUMMARY OF GROUP G CHARACTERISTICS

1.1 DESCRIPTION

Group G consists of sites containing mixed waste spills. This includes the following SWMUs:

- 128, 134 Lithium and Uranium Contaminated Oil Burn Pit
- 136.1, 136.2, 136.3 Chromium and Uranium Contaminated Cooling Tower Ponds
- 116.1, 116.2, 157.1, 157.2 Multiple Solvent Spill and Uranium Contaminated Solvent Spills

1.2 SOURCE CHARACTERIZATION

Contamination at the oil burn pit resulted from the burning of ten drums of oil with depleted uranium, and lithium from subsequent use of the area for destruction of 400 to 500 pounds of lithium.

Contamination from the cooling tower ponds includes chromium from the cooling tower blowdown, uranium and carbon tetrachloride from the machine-tool storage, and uranium believed to have been present in the fill used to cover the ponds.

The solvent spill sites, SWMUs 116.1, 116.2, 157.1 and 157.2, may contain uranium, though cleanup efforts have reduced surface radioactivity to background levels at SWMU 157. Beryllium and various solvents, including carbon tetrachloride are likely to be present.

1.3 POTENTIAL PATHWAYS

Surface water is not considered a pathway since all surface waters flow to the retention ponds which are evaluated as SWMU 142.

The air pathway is negligible since surface activity is not present at SWMU 157.1 and 157.2 and solvents that were spilled at SWMUs 116.1, 116.2, 157.1 and 157.2 would have previously volatilized or travelled through the soil. SWMUs 128, 134, 136.1, 136.2, and 136.3 have been paved.

The primary pathway is through groundwater. It is possible that some of the radioisotopes were adsorbed by the soil and may have leached to groundwater. The solvents likely to have spilled at SWMUs 116 and 157 are highly mobile through soil.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purposes of investigation of these SWMUs are as follows:

1) Determine whether or not contamination exists in the soil (source characterization)

2) Determine if contaminants are being or have been released to groundwater (pathway characterization)

The investigation will consist of two major tasks. Task 1 is to gather and examine all existing background information and Task 2 consists of field investigations to characterize the sources and pathways. All investigations will follow the procedures in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1-COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. The primary goal of this research is to identify the types of solvents used at this SWMU to quantify the releases and determine their exact location. This task includes the components described below.

2.2.1 Personnel Interviews

Personnel interviews conducted in the past will be reviewed for any information that may assist in determining the direction the field activities should take. Additional employee interviews will be conducted to further characterize these SWMUs prior to field investigations.

2.2.2 Historic Operational Procedures and Remedial Actions

All information on historic operational procedures will be reviewed for site-specific data to determine the types and quantities of solvents and radioisotopes spilled and further characterize cleanup efforts that were made.

2.2.3 Utility Survey

A utility survey will be conducted prior to initiation of field activities to define any hazards presented by these utilities to the field investigation crew.

2.3 TASK 2-FIELD INVESTIGATIONS

The following work plan has been developed based on currently available information. Modifications may be required if further background information indicates that this work has satisfactorily been completed.

2.3.1 Task 2.1 - Radiation Survey

Soil contamination will be evaluated at SWMUs 116.2, 128, 134 and 157 as follows. A grid will be laid out for the potentially contaminated areas. Surface soil count rates will be determined on 10-foot centers for SWMU 116.2, 128, 134 and 30-foot centers for SWMU 157 using a shielded pancake G-M detector and side-shielded FIDLER. Readings will be taken no more than six inches above the surface. All counts will be recorded and hot spots will be marked with a stake.

2.3.2 Task 2.2 - Geophysical Survey

A geophysical survey will be conducted over SWMU 136 to determine and define the lateral and vertical extent of the buried cooling tower ponds. A magnetometer, ground penetrating radar or electromagnetic conductivity techniques will be used to define the boundaries of these ponds.

2.3.3 Task 2.3 - Soil Investigation

Soil samples will be collected at two-foot intervals at SWMUs 136.1, 136.2, and 136.3 as shown on Figure G-1 to a depth of 20 feet. SWMU 136.3 will be used as an indicator for conditions at SWMUs 136.1 and 136.2 since these SWMUs are inaccessible and are likely to contain similar contaminants. Soil samples will be collected at two-foot intervals at all other locations to a depth of 6 feet. SWMU 157 must be further characterized prior to assigning sampling locations and analysis parameters.

Samples taken from SWMUs 128 and 134 will be analyzed for total uranium and lithium. Samples taken from SWMU 136.3 will be analyzed for total uranium, chromium and lithium. Samples taken from SWMUs 116.1 and 116.2 and 157 will be analyzed for volatile organics, beryllium and uranium.

2.3.4 Task 2.2.4-Groundwater Investigation

Three monitor wells will be installed around SWMU 136 and one in SWMU 116.2. The precise location of these wells will be determined based on the results of Task 1 and Tasks 2 through 23. Monitor wells for SWMUs 116.1, 128, 134, and 157 will be installed if background and soil investigations indicate it is necessary. These wells will be constructed according to the specifications in the QAPP. Slug tests will be conducted in every well to obtain further hydrogeologic data. Groundwater will be sampled and analyzed quarterly for one year.

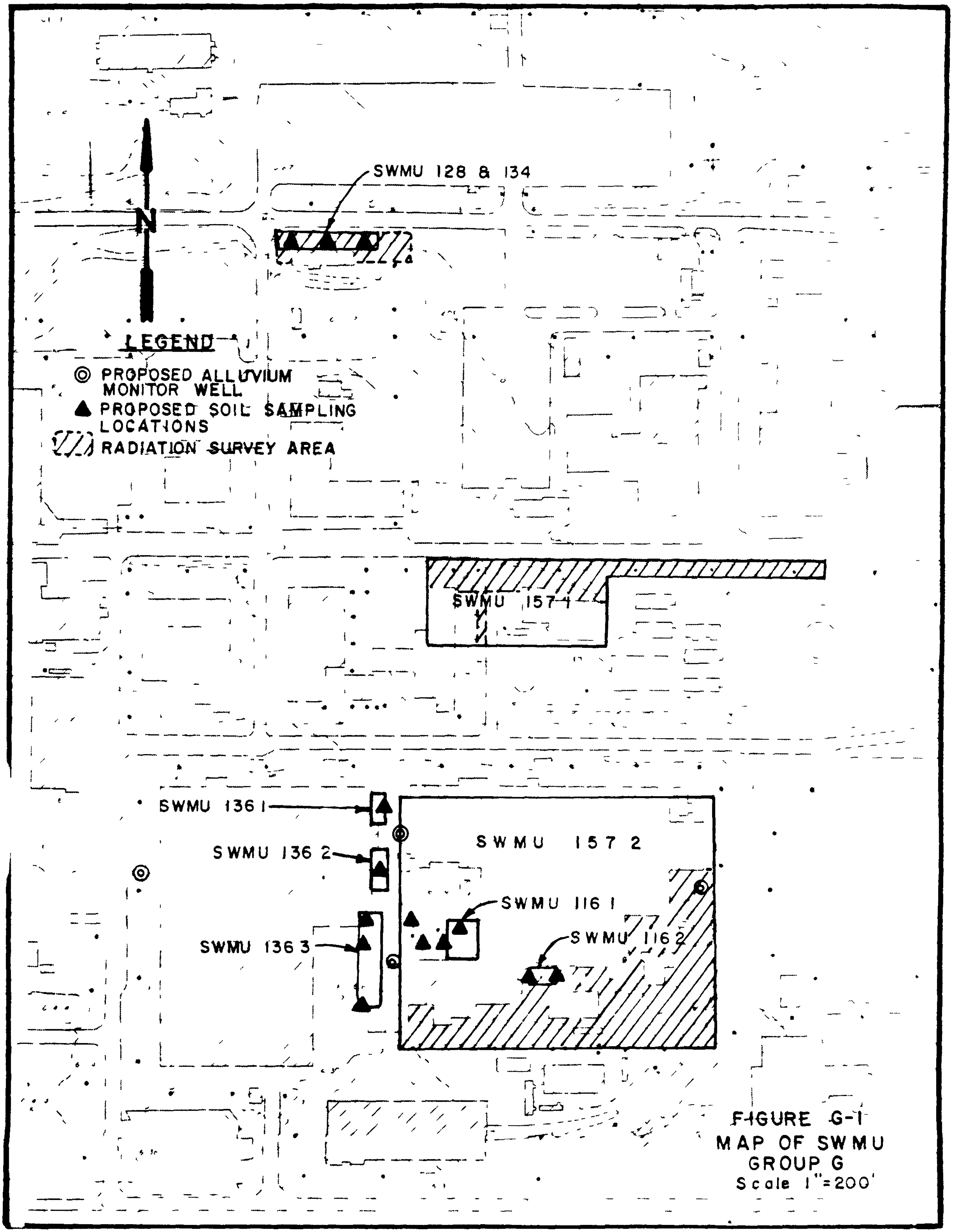

FIGURE G-1
MAP OF SWMU
GROUP G
Scale 1"=200'

APPENDIX H

SWMU GROUP H
SWMUs 131, 143, 156.1
158,SWMU,GROUP H64,
SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP H CHARACTERISTICS

1.1 DESCRIPTION

Group H consists of low priority, inactive SWMUs containing radioactive leaks, spills and discharges shown in figures H-1 and H-2. This includes the following SWMUs:

- 143 Surface Radioactive Effluent Discharges
- 131, 156.1 Contaminated Soil
- 158, 160, 161, 164, Surface Spills

1.2 SOURCE CHARACTERIZATION

Radioactive contamination by plutonium, uranium and americium could have occurred at these SWMUs. SWMU 143 was the old outfall. Contamination by other surface spills (liquid and solid) resulted from SWMUs 158, 160, 161, and 164. SWMUs 131 and 156.1 are the result of contaminated soil disposal.

Cleanup efforts have occurred at SWMUs 143, 160, 161, 164 and no surface activity above background has been detected. In addition to radioactivity, the wastes leaked from these SWMUs were high in nitrates.

1.3 POTENTIAL PATHWAYS

Surface water is not considered a pathway since all surface waters flow to the retention ponds which are evaluated as SWMU 142. If contaminants are found in SWMU 142, then an investigation of the drainages from the Group H SWMUs will be performed.

If surface activity is detected at the unpaved SWMUs, then fugitive dust is a potential pathway.

Groundwater is also a potential pathway, though it is likely that most of the radioisotopes were adsorbed by the soil.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purposes of investigation of these SWMUs are as follows:

1) Determine whether or not contamination exists in the soil (Source Characterization)

2) Determine if contaminants are being or have been released to groundwater (Pathway Characterization)

The investigation will consist of two major tasks. Task 1 is to gather and examine all existing background data to thoroughly understand the problem and prevent duplication of effort. Task 2 consists of field investigations to characterize the sources and pathways. All investigations will follow the procedures in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1-COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. This task includes the components described below.

2.2.1 <u>Personnel Interviews</u>

Personnel interviews conducted in the past will be reviewed for any information that may assist in the direction the field activities should take. Additional employee interviews will be conducted to further characterize these SWMUs prior to field investigations.

2.2.2 Historic Operational Procedures and Remedial Actions

All information on historic operational procedures will be reviewed for site-specific data to further characterize the waste lines' contents, spills and remedial actions previously performed. These data will come from Plant files if available. Previous consultants will be consulted if necessary.

2.2.3 Utility Survey and Engineering Drawings

A utility survey will be conducted prior to initiation of field activities to define any hazards presented by these utilities to the field investigation. Engineering drawings will be used to locate buried waste lines and determine sampling/excavation locations.

2.3 TASK 2- FIELD INVESTIGATIONS

The following workplan has been developed based on available existing information. Modifications may be required if further background information indicates that this work has satisfactorily been completed.

2.3.1 Task 2.1-Preliminary Radiation Survey

A radiometric survey will be conducted over the areas of the buried pipelines, discharges and spills. The purpose of the survey is to delineate any areas in which the soil sampling effort should be concentrated.

The survey will be conducted using a side-shielded field instrument for detecting low energy radiation (FIDLER) and a shielded pancake G-M detector. The measurements will be taken no more than six inches above the ground. Any readings significantly above background at the Rocky Flats Plant (250 counts/minute) will be recorded and a stake with an identification number will be driven at the location for future reference.

2.3.2 Task 2.2-Soil Investigation

Soils will be analyzed to determine if soil contamination exists. Available information indicates that the soil samples should be analyzed for plutonium, uranium and americium. Nitrates are not expected to be detectable in the soil.

Surface and Near-Surface Investigations-Soil contamination will be evaluated as follows. A grid will be laid out over the potentially contaminated area. Surface soil count rates will be determined on 20-foot centers for SWMUs 158, 160, and 161, and on 5-foot centers for SWMU 131 using a shielded pancake G-M detector and side-shielded FIDLER. In addition, any hot spots will be identified during a walkover survey. Soil samples (0 to 3") will be collected at the hot spots and grid points. At a depth of 1 foot, another set of side-shielded FIDLER and shielded G-M detector counts will be taken at each grid point and hot spot; 12 to 15" soil samples will also be taken at each hot spot and grid point. A set of FIDLER and G-M detector readings will be taken at a depth of 24" at any locations that had an above background reading at a depth of 12". Soil samples (24-27") will be collected at each of these locations. Boreholes will be placed at selected locations that exhibit elevated activity at a depth of 24". Boreholes will be continuously sampled from 2 feet to a nominal depth of 10 feet. The soil samples will be divided into 1-foot increments and screened using a shielded pancake G-M detector and a side-shielded FIDLER. Selected soil samples (no more than 50% of those collected) will be analyzed for $Pu^{238, 232, 240}$, Am^{241}, $U^{234, 235, 238}$ by alpha spectroscopy, as needed. This procedure will define the limits and depth of contamination.

A soil sampling borehole will be drilled through the asphalt to a depth of 10 feet of SWMU 156.1 to determine the adequacy of the undocumented cleanup activity.

2.3.3 - Task 2.3-Groundwater Investigation

If there is evidence, based on the soil investigations, that the contaminants have reached the groundwater, monitor wells will be installed, and slug tests will be conducted in all wells.

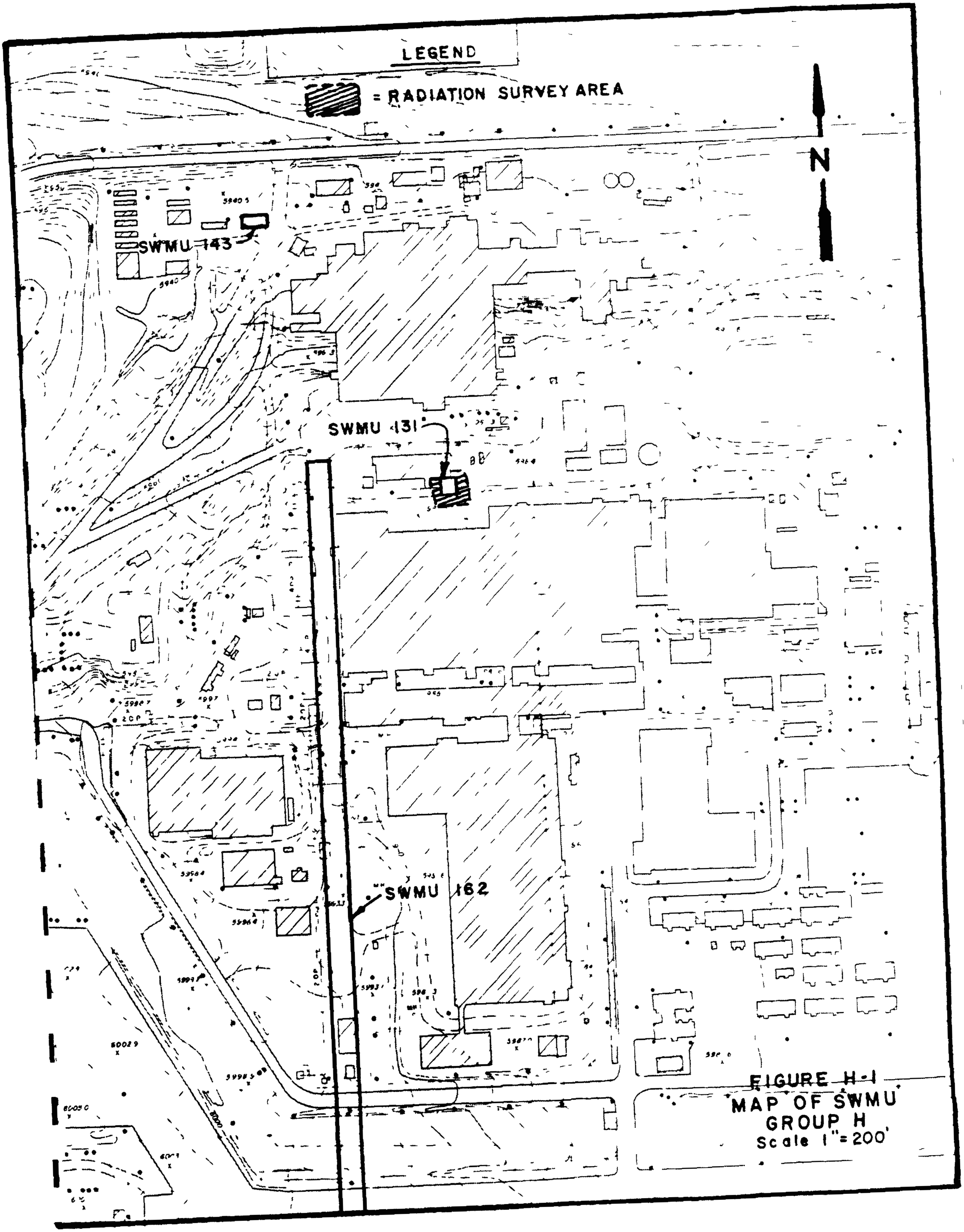

FIGURE H-1
MAP OF SWMU
GROUP H
Scale 1" = 200'

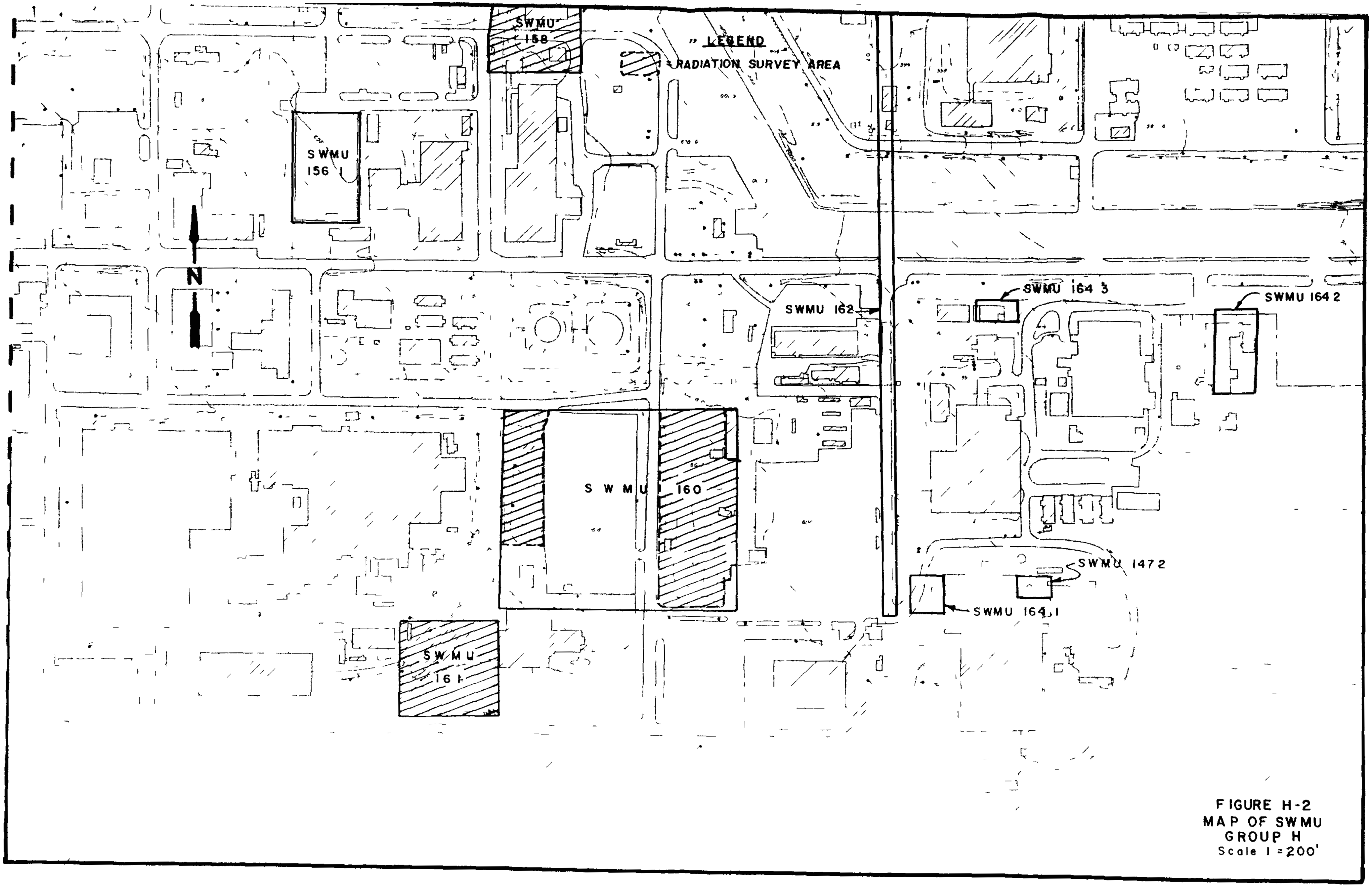

FIGURE H-2
MAP OF SWMU
GROUP H
Scale 1 = 200'

APPENDIX I

SWMU GROUP I
SWMUs 165, 173 and 184
SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP I CHARACTERISTICS

1.1 DESCRIPTION

SWMU Group I consists of SWMUs 165, 173 and 184. SWMU 165 is the Triangle Area which at one time was used to store approximately 6,000 drums containing plutonium contaminated waste materials. SWMU 173 consists of Building 991 and the associated tunnels and vaults. SWMU 184 is a 50-foot x 50-foot area between Buildings 992 and 991 (Figure I-1).

1.2 SOURCE CHARACTERIZATION

Contamination by surface spills (liquid and solid) resulted from SWMU 165. Incidents involving uranium, plutonium, and beryllium have been reported at Building 991. There are also indications in the Part B Application, Appendix 1 that one of the vaults has some unspecified radionuclide contamination and that Building 991 may be contaminated with plutonium, americium, and beryllium.

1.3 POTENTIAL PATHWAYS AND RECEPTORS

The Rocky Flats Alluvium is permeable and present in the area underlying the Triangle Area, Building 991, tunnels, and vaults. The depth to the water table at the site is unknown, but the tunnels and vaults are unlikely to be below the water table. Additionally, contamination is possible in the bedrock aquifer as the building, tunnels, and vaults may be in direct contact with the bedrock.

Remedial cleanup procedures have already been performed at SWMU 165 with removal of soil surface contamination. Groundwater is also a potential pathway, though it is likely that most of the radioisotopes were adsorbed by the soil.

2.0 INVESTIGATION APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purpose of this investigation is to evaluate:

- Determine whether or not contamination exists in the soil (Source Characterization).

- The building, tunnel, and vault area of Building 991 and the steam-cleaning area and to determine if they are contaminated with radionuclides or beryllium (Source Characterization).

- The soils and groundwater in the vicinity of these SWMUs to determine if they have become contaminated (Pathway Characterization).

2.2 COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will reviewed and integrated into the plan. This task includes, but is not limited to the components described below.

2.2.1 Personnel Interviews

Past personnel interviews will be reviewed for any site-specific data which would assist in field activity planning.

2.2.2 Utility Surveys

Prior to the initiation of field activities, a utility survey will be conducted to adequately define the location of potential hazards to field personnel or plant activities. This should include procurement of engineering drawings, as-built drawings, utility drawings where available and interviews with site personnel to determine the probable tunnel, and vault locations as well as the location of existing footing drains and their discharge locations.

2.2.3 Engineering Drawings

A review of available engineering drawings will be conducted to provide technical information. Specific drawings of interest will include available as-built plans, permit drawings, plot plans, and construction plans. These plans will be reviewed with the intent of supplementing SWMU survey/location information, defining the depth and extent of the unit, determining specific details of unit such as foundation drains, etc., that may affect the investigation and provide information on the unit's installation and operation.

2.2.4 Historic Operational Procedures

All available information on historic operational procedures should be reviewed for site-specific data pertaining to site history, past wastes treatment and disposal practices, and other pertinent information.

2.2.5 Historic Remedial Action

All available information in Plant files will be reviewed for information concerning past investigations of site contamination, geologic, hydrogeologic conditions, and any prior remedial actions. Where appropriate, consultants who performed previous investigations at the site will be contacted for additional information about the site.

2.2.6 Other Pertinent Information

Any information uncovered during the course of the previously mentioned reviews which contains additional data appropriate to the investigation will be considered before field activities commence.

2.3 Task 2 FIELD INVESTIGATION

The following scope of work has been developed for SWMU Group I based on available existing information. This sampling plan includes soils investigations, radiometric surveys, and a hydrogeologic investigation. Additional phases may be necessary to ascertain the lateral and vertical extent of contamination, contingent upon the results of the radiometric survey, the soil boring program, and the groundwater investigation.

The objectives will be accomplished by establishing the waste characteristics in order to identify and assess exposure and risk to human health and the environment. In addition, potential treatment, disposal, and/or control options will be identified, if deemed necessary. The elements involved in implementing this task are outlined below.

2.3.1 Task 2.1- Radiometric Survey

A radiometric survey will be conducted over the area around the buildings. Continuous readings will be taken on a 30-foot grid spacing.

Sampling Methodology-The survey will be conducted using a side-shielded field instrument for detecting low energy radiation (FIDLER). The measurement will be taken no more than six inches above the ground. Readings will be recorded at each grid point. Anomalously high readings will be marked by a stake or nail with an identification number driven at the location so that it may be located with accepted ground survey techniques.

2.3.2 Task 2.2-Soil Investigation

A soil investigation will be conducted to determine the nature and extent of contamination. Soil sampling locations for SWMU 165 will be determined by data collected in Task 1 regarding the location of past spills. The sampling will be conducted around the building, steam-clean area, and near the suspected location of the tunnels and vaults. Precise sampling locations will be based on results of the radiometric survey. Soil samples will be analyzed for radionuclides and beryllium.

Sampling Methodology- Soil samples will be taken from 5 locations. Samples will be collected and analyzed for radionuclides using hollow-stem, dry core barrels. Each of the borings will completed to the water table. Samples will be collected at five-foot intervals or as determined in the field by the hydrogeologist. Samples will then be collected every 10 feet or upon change in lithology to bedrock. The samples will be sent to the laboratory for analysis. Samples will be analyzed for radionuclides and beryllium.

If contamination is detected during the initial sampling effort, additional phases could be required in order to establish the nature and extent of this contamination.

2.3.3 Task 2.3-Surface Water Investigation

Surface water will be sampled at two locations: the spring to the east of Building 991 and the sump to the southwest of Building 991.

Sampling Methodology-During Phase 1 of the investigation, samples will be collected in accordance with the QAPP. Analyses of the samples will be completed for radionuclides and beryllium.

2.3.4 Task 2.4-Hydrogeologic Investigation

A hydrogeologic investigation will be conducted in order to ascertain the nature of groundwater occurrence at the site and to determine whether groundwater has been contaminated from releases from this SWMU Group. For SWMU 173, five well locations will be selected to provide upgradient information as well as information around the buildings (991, 992), vaults, and tunnels which have the greatest potential for contamination based on information from Tasks 2.1 and 2.2. One alluvial and one bedrock well (cluster set) will be installed at each location so that the wells in each set are a maximum of 10 feet apart.

Drilling and well installation will follow the guidelines for alluvial and bedrock wells specified in the project QAPP.

Groundwater samples will be collected quarterly for one year for analysis according to the procedures outlined in the project QAPP and sent to the laboratory for radionuclides and beryllium analysis. Water levels will be recorded one day after development of the well and again at the time of sampling.

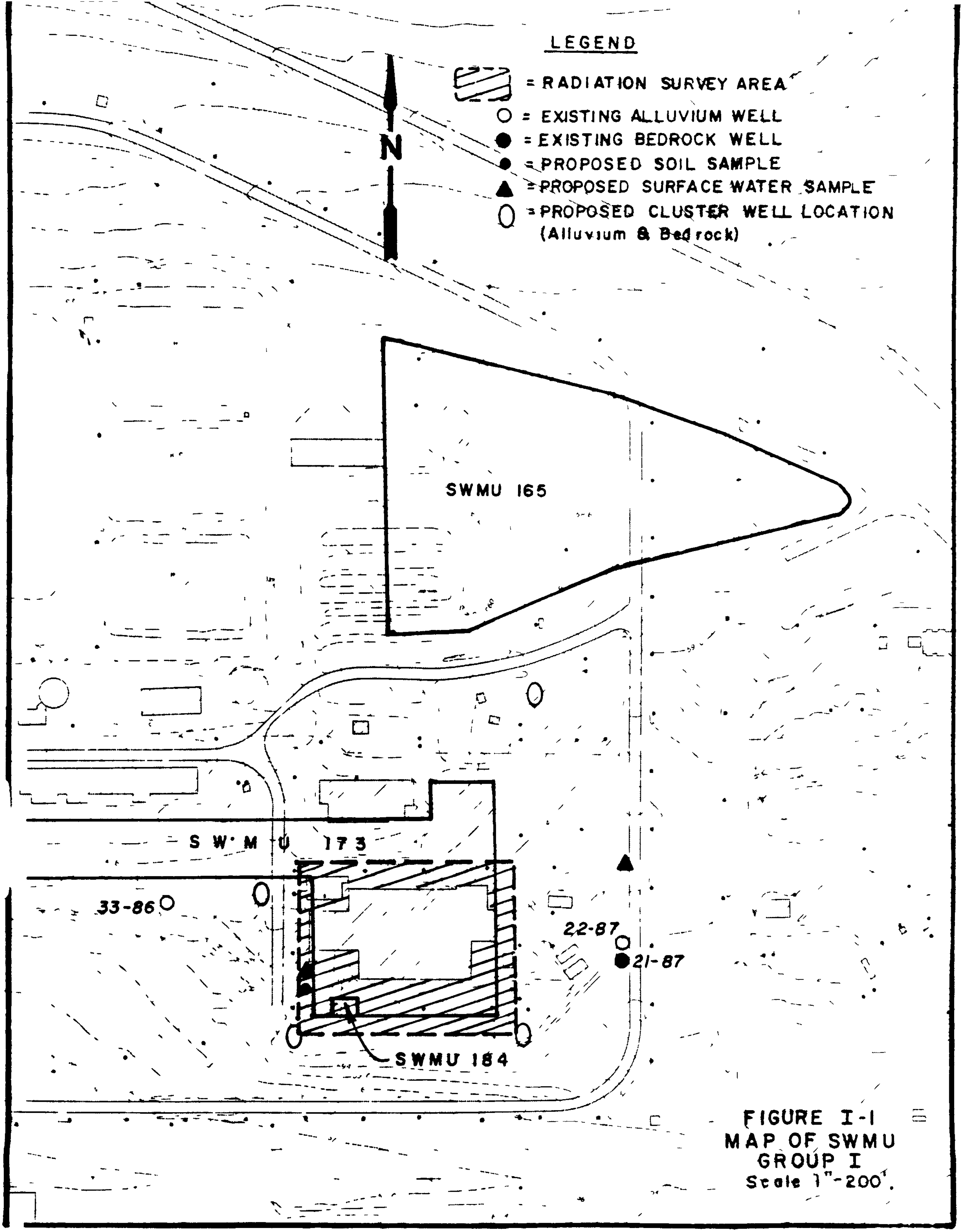

FIGURE I-1
MAP OF SWMU
GROUP I
Scale 1"-200'.

APPENDIX J

SWMU GROUP J

SWMU 172

SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP J CHARACTERISTICS

1.1 DESCRIPTION

SWMU Group J consists of SWMU 172, Central Avenue Waste Spill (Figure J-1). This waste spill occurred during the 1968 cleanup of the 903 drum storage area. The spill occurred during transportation of the waste to Building 771 when one or two of the drums were punctured with a forklift. The drums leaked onto the asphalt of the westbound lane of Central Avenue and the northbound lane of Sixth Avenue from the 903 drum storage area to Building 771, where they were unloaded. The road was subsequently paved over.

1.2 SOURCE CHARACTERIZATION

Plutonium and carbon tetrachloride may be present along the roadway and associated surface water drainages. The road is approximately one mile long.

1.3 POTENTIAL PATHWAYS AND RECEPTORS

Soils adjacent to the affected roadway and the asphalt may have been contaminated by runoff from the road. Fugitive dust could create an air pathway for plutonium from the soil adjacent to the roadway.

Rocky Flats Alluvium, which is permeable, underlies the roadway and the surface water drainages. The groundwater which occurs in the alluvium should be considered a pathway.

2.0 INVESTIGATION APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purpose of this investigation is to evaluate:

(1) roadway and ditches to determine if they are contaminated with radionuclides or carbon tetrachloride (source characterization); and

(2) groundwater and surface water contamination (pathway characterization).

2.2 COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. This task includes, but is not necessarily limited to the components presented below.

2.2.1 Personnel Interviews

Past personnel interviews will be reviewed for any site-specific data which would assist in field activity planning. Additional interviews will be conducted where judged appropriate. Topics which require additional clarification include the exact pathway the spill followed, and the time paving material was applied to the area.

2.2.2 Utility Surveys

Prior to the initiation of field activities, a utility survey will be conducted to adequately define the location of potential hazards to field personnel or plant activities. This should include procurement of engineering drawings, as-built drawings, utility drawings where available and interviews with site personnel.

2.2.3 Historic Remedial Actions

All available information in Plant files will be reviewed for information concerning past investigations of site contamination, geologic, hydrogeologic conditions, and any prior remedial actions. Where appropriate, consultants who performed previous investigations at the site will be contacted for additional information about the site.

2.2.4 Other Pertinent Information

Any information uncovered during the course of the previously mentioned reviews which contains additional data appropriate to the investigation will be considered before field activities commence.

2.3 TASK 2- FIELD INVESTIGATION

The following scope of work has been developed for SWMU 172 based on available existing information. This sampling plan uses a three-phased investigation to insure both the lateral and vertical extent of contamination is ascertained. During the initial phase of the investigation, a radiometric survey will be conducted over the drainage ditch area to determine if surface contamination is present. Soil samples will be collected at locations where radiometric readings above background were detected and at locations most likely to be contaminated.

During the second phase, supplemental samples will be collected to determine the lateral extent of the contamination. The third phase will be initiated to determine the vertical extent of contaminant migration using primarily soil borings and alluvial groundwater wells.

2.3.1 Task 2.1-Radiometric Survey

A radiometric survey will be conducted over the area near the spill and down the hillside including the roadway and surface water drainages. Continuous readings will be taken along traverses perpendicular to the probable pathway. The traverses will be spaced approximately 30 feet apart and identified by nails with washers driven at the centerline of the road.

Sampling Methodology-The survey will be conducted using a side-shielded field instrument for detecting low energy radiation (FIDLER). The measurements will be taken from no more than six inches above the ground. All readings will be recorded at specified intervals from the centerline of the road.

2.3.2 Task 2.2-Soil Investigation

Soil/asphalt sampling will be conducted to determine the nature and extent of contamination. The sampling will be conducted in the roadway and associated surface water drainages at locations where the truck may have stopped and allowed a greater time for leakage (i.e. stop signs, railroad crossing and where radiometric surveys indicate hot spots). Soil samples will be analyzed for plutonium and volatile organic compounds.

Sampling Methodology- During the initial phase of the investigation, shallow, near surface, soil samples will be collected from 0 to 6 inches using hand augers, and analyzed for plutonium and volatile organic compounds. The soil samples will be sent to the laboratory for analysis. Asphalt samples will be collected using asphalt core drilling equipment. Composite samples of the asphalt will be submitted for laboratory analysis. Samples will be analyzed for plutonium and volatile organics.

2.3.3 Additional Investigations

If contamination is detected during this first phase, additional phases may be required to collect asphalt and shallow soil samples to sufficiently delineate the vertical and lateral extent of contamination. The second phase might require up to 80 additional shallow soil/asphalt samples to sufficiently delineate the lateral extent of contamination. Where manmade fill is suspected, the samples may be extended to the suspected surface level at the time of the spill.

The third phase will require up to 10 soil borings. These borings will assist in determination of the vertical extent of contaminant migration. Soil samples will be collected for analysis at five-foot intervals, or as warranted base on field observations by the field hydrogeologist. Further monitoring wells will be installed should evidence of contamination suggest that the groundwater has been affected. Borings which have contaminants present will be completed as alluvial groundwater monitoring wells. The wells will be constructed of two-inch stainless steel casing and continuous wire-wrapped, 0.020 inch slot stainless steel screen.

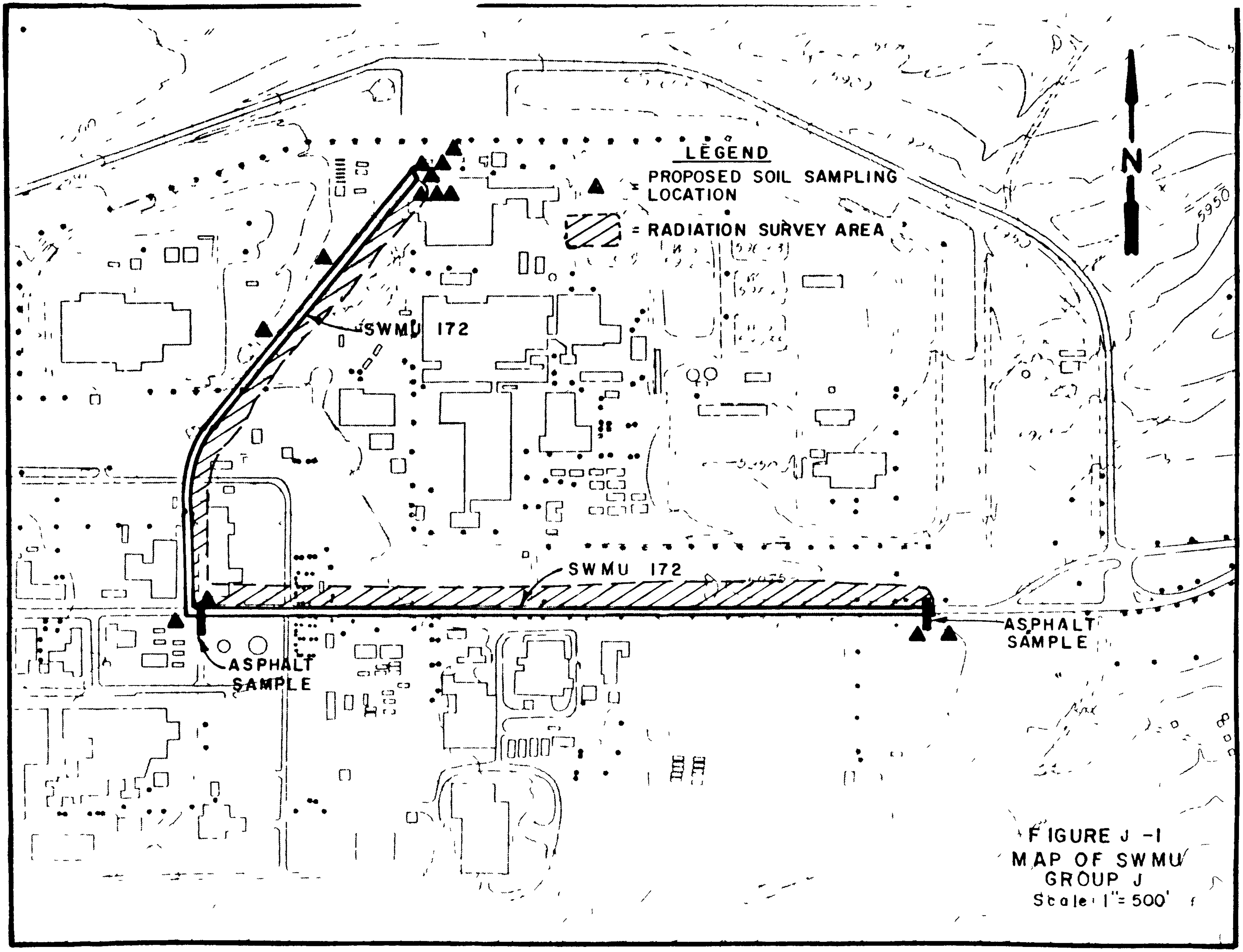

FIGURE J -1
MAP OF SWMU
GROUP J
Scale 1" = 500'

APPENDIX K

SWMU GROUP K
SWMUs 148, 197 and 199
SAMPLING PLAN

1.0 SUMMARY OF SWMU GROUP K CHARACTERISTICS

1.1 DESCRIPTION

Group K consists of two low priority SWMU sites that had negative findings in the Preliminary Site Investigation (PSI), the Preliminary Assessment (PA), and the Federal Facility Site Discovery and Identification Findings (FFSDIS) and one offsite area.

This group consists of SWMU 148, Waste Spills; SWMU 197, Scrap Metal Sites - 500 Area; and Site 199, offsite Soil Contamination.

At SWMU 148 several spills of nitrate wastes occurred around the outside of the Health Physics Laboratory, Buidling 123 (Figure 3-10). Dates and volumes of spills are unknown. Spilled wastes may have contained radionuclides.

SWMU 197 is the scrap metal site (nonradioactive, nonhazardous, nonprecious metals) southwest of Building 559. During the CEARP Phase I interviews, it was stated that there may have been some old transformers that contained PCB's stored at these areas. However, no transformers were found during excavation of this area upon construction of the Perimeter Security Zone (PSZ).

SWMU 199 is the offsite soil contaminated area in Section 7, west and south of Great Western Reservoir and in Section 18, west of Mower Reservoir. Remediation has been performed at various areas within both sections.

2.0 INVESTIGATIVE APPROACH

2.1 OBJECTIVES OF THE INVESTIGATION

The purpose of the investigation of these SWMUs is to:

1) Characterize the types and concentrations of contaminants buried in the trenches (Source Characterization),

2) Determine if any contaminants are being released at the surface of the pits or to the groundwater (Pathway Characterization), and

3) To verify the effectiveness of remediation actions performed in SWMU 199.

The sampling program will consist of two major tasks. Task 1 concentrates on gathering all existing background data to ensure that additional tasks are optimized. Task 2 consists of field investigation subtasks to characterize the source and pathways. All investigations will follow the procedures specified in the Low Priority SWMU Quality Assurance Project Plan and Health and Safety Plan.

2.2 TASK 1-COLLECTION AND REVIEW OF EXISTING INFORMATION

Any data generated or obtained between preparation of this plan and its implementation will be reviewed and integrated into the plan. This task will include, but is not limited to, the components described below.

2.2.1 Collection and Analysis of Existing Data

Information from monitoring wells installed in 1987 will be obtained and evaluated to determine if additional wells are needed to accurately assess the impact of these SWMUs on groundwater quality.

2.2.2 Historical Operational Procedures

All information available from Plant files or from interviews from people involved with the construction and operation of the trenches will be reviewed for site-specific data pertaining to site history, past waste discharges, and any other pertinent information.

2.2.3 Other Sources

Any information uncovered during the course of other Task 1 activities which includes additional date pertinent to the investigation will be considered before field activities commence.

2.3 TASK 2-FIELD INVESTIGATIONS

The investigations planned for Task 2 are based on information available at the time of preparation of this sampling plan. Modifications to the field activities may be required.

2.3.1 Task 2.1 Surface Soil Sampling

Two locations at each site to be determined under Task 1, will be sampled. Samples will be collected using a hand auger from ground surface to a depth of 24 inches. Samples from SWMU 148 will be analyzed for nitrates and radionuclides. Samples collected from SWMU Site 197 will be analyzed for organics. Samples collected from Site 199 will be analyzed for plutonium after remedial action is completed.

APPENDIX L

HAZARDS RANKING AND GROUP SCORES

HAZARD RANKING SYSTEM AND
MODIFIED HAZARD RNAKING SYSTEM

APPENDIX L

HAZARDS RANKING SYSTEM
AND
GROUP SCORES

The Hazard Ranking System (HRS) was developed by the U.S. Environmental Protection Agency (EPA) to provide a means for "applying uniform technical judgment regarding the potential hazards (to humans or the environment) presented by a facility relative to other facilities." The HRS does not deal with radiation hazards or with the probability or magnitude of harm that could result from a facility, nor does it address the feasibility, desirability, or degree of cleanup required. Under the direction of the U.S. Department of Energy (DOE), Battelle Pacific Northwest Laboratories developed the Modified Hazard Ranking System (mHRS) to account for the hazards associated with radioactive contaminants.

The HRS and mHRS assign three hazard mode scores to a site. The Migration Mode Score reflects the potential for harm to humans or the environment from migration of a hazardous substance through either the ground water, surface water, or air pathways. The Fire/Explosion Mode Score reflects the potential for harm from substances that can explode or cause fires. The Direct Contact Mode Score reflects the potential for harm from direct contact with hazardous substances at the site. The Fire/Explosion and Direct contact Mode Scores are used to identify facilities requiring emergency action.

The Migration Mode Score is the result of evaluation of the groundwater, surface water, and air migration routes. Facilities, including Federal facilities, with a Migration Mode Score of 28.5 are placed on the National Priorities List for initial attention under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

Guidance for the application of the HRS is contained in EPA Directive No. 9355.0-3, "Uncontrolled Hazardous Waste Site Ranking System-A Users Manual."

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: Low Priority SWMU Group A & B

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility:

Walnut Creek Retention Ponds

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	37	10
Surface Water Route Score (Ssw)	80	9
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	51	8
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine low priority SWMU grouping prioritization only and are not intended as official HRS/MHRS scores.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: SWMU Group C

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility:

Woman Creek Retention Ponds

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	37	10
Surface Water Route Score (Ssw)	52	2
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	37	6
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine low priority SWMU grouping prioritization only and are not intended as official HRS/MHRS scores.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: Low Priority SWMU Group D

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility:

Original landfill and ash pits

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	29	8
Surface Water Route Score (Ssw)	0	0
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	17	5
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine low priority SWMU grouping prioritization only and are not intended as official HRS/MHRS scores.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: Low Priority SWMU Group E

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility:

Chemical spill sites

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	28	0
Surface Water Route Score (Ssw)	0	0
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	16	0
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine low priority SWMU grouping prioritization only and are not intended as official HRS/MHRS scores.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: Low Priority SWMU Group F

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility:

Sludge Trenches

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	23	8
Surface Water Route Score (Ssw)	0	0
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	13	5
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine low priority SWMU grouping prioritization only, and are not intended as official HRS/MHRS scores.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: Low Priority SWMU Group G

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility:

Mixed waste spill sites

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	23	8
Surface Water Route Score (Ssw)	0	0
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	13	5
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine lo priority SWMU grouping prioritization only and are not intended as official HRS/MHRS scores.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: Low Priority SWMU Group H

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility:

Radioactive and nitrate contaminated spill sites

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	11	10
Surface Water Route Score (Ssw)	0	0
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	6	6
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine low priority SWMU grouping prioritizaton only and are not intended as official HRS/MHRS scores.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: Low Priority SWMU Group I

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility: Triangle Area, Radioactive vaults and steam cleaning area

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	35	10
Surface Water Route Score (Ssw)	0	0
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	20	6
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine low priority SWMU grouping prioritizatoin and are not intended as official HRS/MHRS scores.

HAZARD RANKING SYSTEM/MODIFIED HAZARD RANKING SYSTEM COVER SHEET

Facility: Rocky Flats

Site Name: Low Priority SWMU Group J

Name of Reviewer: Advanced Sciences, Inc.

Date: May 1988

General description of the facility:

Central Avenue Spill

Scores:

	Chemical	Radioactive
Groundwater Route Score (Sgw)	14	5
Surface Water Route Score (Ssw)	0	0
Air Route Score (Sa)	0	0
Total Migration Hazard Mode Score (Sm)	8	3
Fire and Explosion Hazard Mode (Sfe)	0	0
Direct contact Hazard Mode (Sdc)	0	0

Calculations are based on available information to determine low priority SWMU grouping prioritization only and are not intended as official HRS/MHRS scores.

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTIPLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE	0 45	45	1	45	45	Four volatile organics detected in groundwater
If Observed Release is Given a Score of 45 Proceed to Line 4						
If Observed Release is Given a Score of 0 Proceed to Line 2						
2. ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3		2		6	
B. Net Precipitation	0 1 2 3		1		3	
C Permeability of the Unsaturated Zone	0 1 2 3		1		3	
D Physical State	0 1 2 3		1		3	
TOTAL ROUTE CHARACTERISTICS SCORE					15	
3 CONTAINMENT	0 1 2 3		1		3	
4 WASTE CHARACTERISTICS						Toxicity 3, Persistence 3-tetrachloroethylene,
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	
B Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	8	1	8	8	Quantity unknown, worst case assumed
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	7	1	7	26	Total uranium 156 pCi/l
B Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine with available data
TOTAL WASTE CHARACTERISTICS SCORE.						
CHEMICAL				26	26	
RADIOACTIVE				7	26	
5 TARGETS						Drinking water use, alternate source available,
A. Groundwater Use	0 1 2 3	2	3	2	9	
B Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	16	1	12	40	Nearest well 1 to 2 miles
TOTAL TARGETS SCORE				18	49	Population 190
6 CALCULATION						
If Line 1 is 45 Multiply 1 x 4 x 5						
If Line 1 is 0, Multiply 2 x 3 x 4 x 5						
CHEMICAL				21060	57330	
RADIOACTIVE				5670	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 37

RADIOACTIVE Sgw = 10

SITE Low Priority, Inactive SWMU Group A & B

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTI-PLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE	0 45	45	1	45	45	Four volatile organics detected in groundwater
If Observed Release is Given a Score of 45 Proceed to Line 4						
If Observed Release is Given a Score of 0 Proceed to Line 2						
2 ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3		2		6	
B Net Precipitation	0 1 2 3		1		3	
C Permeability of the Unsaturated Zone	0 1 2 3		1		3	
D Physical State	0 1 2 3		1		3	
TOTAL ROUTE CHARACTERISTICS SCORE					15	
3 CONTAINMENT	0 1 2 3		1		3	
4 WASTE CHARACTERISTICS						Toxicity 3, Persistence 3-tetrachloroethylene,
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	quantity unknown-worst case
B Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	8	1	8	8	assumed
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	7	1	7	26	Total uranium 156 pCi/l
B Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine with available data
TOTAL WASTE CHARACTERISTICS SCORE						
CHEMICAL				26	26	
RADIOACTIVE				7	26	
5 TARGETS						Drinking water use,
A. Groundwater Use	0 1 2 3	2	3	6	9	alternate source available
B Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	12	1	12	40	Nearest well 1-2 miles Population 190
TOTAL TARGETS SCORE				18	49	
6 CALCULATION						
If Line 1 is 45, Multiply 1 x 4 x 5						
If Line 1 is 0 Multiply 2 x 3 x 4 x 5						
CHEMICAL				21060	57330	
RADIOACTIVE				3670	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 37

RADIOACTIVE Sgw = 10

SITE Low Priority, Inactive SWMU Group c

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTIPLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE If Observed Release is Given a Score of 45 Proceed to Line 4 If Observed Release is Given a Score of 0 Proceed to Line 2	0 45	0	1	0	45	No contamination in adjacent down-gradient monitor well
2. ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3	3	2	6	6	Depth 0 to 20 feet
B. Net Precipitation	0 1 2 3	0	1	0	3	Net ppt <-10 inches
C. Permeability of the Unsaturated Zone	0 1 2 3	3	1	3	3	Highly permeable
D Physical State	0 1 2 3	3	1	3	3	Liquid assumed present
TOTAL ROUTE CHARACTERISTICS SCORE				12	15	
3. CONTAINMENT	0 1 2 3	3	1	3	3	Unlined landfill
4 WASTE CHARACTERISTICS						
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	Unknown-worst case assumed
B. Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	8	1	8	8	Unknown-worst case assumed
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	7	1	7	26	Total uranium 156 pCi/l
B. Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine with available data
TOTAL WASTE CHARACTERISTICS SCORE						
CHEMICAL				26	26	
RADIOACTIVE				7	26	
5 TARGETS						
A. Groundwater Use	0 1 2 3	2	3	6	9	Drinking water use, alternate source available
B Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	12	1	12	40	Nearest well 1-2 miles Population 190
TOTAL TARGETS SCORE				18	49	
6 CALCULATION If Line 1 is 45 Multiply 1 x 4 x 5 If Line 1 is 0, Multiply 2 x 3 x 4 x 5						
CHEMICAL				16848	57330	
RADIOACTIVE				4536	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 29

RADIOACTIVE Sgw = 8

SITE Low Priority, Inactive SWMU Group D

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTIPLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE	0 45	45	1	45	45	Four volatile organics detected in groundwater
If Observed Release is Given a Score of 45 Proceed to Line 4						
If Observed Release is Given a Score of 0 Proceed to Line 2						
2 ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3		2		6	
B Net Precipitation	0 1 2 3		1		3	
C Permeability of the Unsaturated Zone	0 1 2 3		1		3	
D Physical State	0 1 2 3		1		3	
TOTAL ROUTE CHARACTERISTICS SCORE					15	
3. CONTAINMENT	0 1 2 3		1		3	Uncontained leaks
4 WASTE CHARACTERISTICS						Toxicity 3, Persistence 3 tetrachloroethylene
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	
B Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	2	1	2	8	41-250 drums
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	0	1	0	26	No radioactive sources
B Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	
TOTAL WASTE CHARACTERISTICS SCORE. CHEMICAL				20	26	
RADIOACTIVE				0	26	
5 TARGETS						
A. Groundwater Use	0 1 2 3	2	3	6	9	Drinking water use with alternate source available
B Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	12	1	12	40	Nearest well 1-2 miles Population 190
TOTAL TARGETS SCORE				18	49	
6. CALCULATION						
If Line 1 is 45 Multiply 1 x 4 x 5						
If Line 1 is 0, Multiply 2 x 3 x 4 x 5						
CHEMICAL				16200	57330	
RADIOACTIVE				0	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 28

RADIOACTIVE Sgw = 0

SITE: Low Priority, Inactive SWMU Group E

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTIPLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE	0 45	0	1	0	45	No evidence for contribution to detected groundwater contamination
If Observed Release is Given a Score of 45 Proceed to Line 4						
If Observed Release is Given a Score of 0 Proceed to Line 2						
2. ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3	3	2	6	6	Depth 0 to 20 feet
B. Net Precipitation	0 1 2 3	0	1	0	3	Net ppt <-10 inches
C. Permeability of the Unsaturated Zone	0 1 2 3	3	1	3	3	Highly permeable
D Physical State	0 1 2 3	3	1	3	3	Liquid, sludge
TOTAL ROUTE CHARACTERISTICS SCORE				12	15	
3. CONTAINMENT	0 1 2 3	3	1	3	3	Unlined trenches
4 WASTE CHARACTERISTICS						
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	Worst case assumed
B Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	2	1	2	8	41 to 250 drums
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	7	1	7	26	Total uranium 156 pCi/l
B Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine with available data
TOTAL WASTE CHARACTERISTICS SCORE.						
CHEMICAL				20	26	
RADIOACTIVE				7	26	
5. TARGETS						
A. Groundwater Use	0 1 2 3	2	3	6	9	Drinking water use, alternate source available,
B Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	12	1	12	40	nearest well 1-2 miles
TOTAL TARGETS SCORE				18	49	Population 190
6. CALCULATION						
If Line 1 is 45, Multiply 1 x 4 x 5						
If Line 1 is 0, Multiply 2 x 3 x 4 x 5						
CHEMICAL				12960	57330	
RADIOACTIVE				4536	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 23

RADIOACTIVE Sgw = 8

SITE Low Priority, Inactive SWMU Group F

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTIPLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE If Observed Release is Given a Score of 45 Proceed to Line 4 If Observed Release is Given a Score of 0 Proceed to Line 2	0 45	0	1	0	45	Specific solvents have not been identified
2 ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3	3	2	6	6	Depth 0 to 20 feet
B Net Precipitation	0 1 2 3	0	1	0	3	Net ppt <-10 inch
C. Permeability of the Unsaturated Zone	0 1 2 3	3	1	3	3	Highly permeable
D Physical State	0 1 2 3	3	1	3	3	Liquid
TOTAL ROUTE CHARACTERISTICS SCORE				12	15	
3 CONTAINMENT	0 1 2 3	3	1	3	3	Uncontained leaks
4 WASTE CHARACTERISTICS						
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	Worst case assumed
B Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	2	1	2	8	41-150 drums
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	7	1	7	26	Total uranium 156 pCi/l
B Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine with existing data
TOTAL WASTE CHARACTERISTICS SCORE						
CHEMICAL				20	26	
RADIOACTIVE				7	26	
5 TARGETS						Drinking water use, alternate source available,
A. Groundwater Use	0 1 2 3	2	3	2	9	
B Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	12	1	12	40	Nearest well 1-2 miles Population 190
TOTAL TARGETS SCORE				18	49	
6 CALCULATION If Line 1 is 45 Multiply 1 x 4 x 5 If Line 1 is 0 Multiply 2 x 3 x 4 x 5						
CHEMICAL				12960	57330	
RADIOACTIVE				4536	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 23

RADIOACTIVE Sgw = 8

SITE Low Priority, Inactive SWMU Group G

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTI-PLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE	0 45	45	1	45	45	Nitrates in groundwater
If Observed Release is Given a Score of 45 Proceed to Line 4						
If Observed Release is Given a Score of 0, Proceed to Line 2						
2. ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3		2		6	
B Net Precipitation	0 1 2 3		1		3	
C. Permeability of the Unsaturated Zone	0 1 2 3		1		3	
D Physical State	0 1 2 3		1		3	
TOTAL ROUTE CHARACTERISTICS SCORE					15	
3. CONTAINMENT	0 1 2 3		1		3	
4 WASTE CHARACTERISTICS						Toxicity 2, Persistence 0
Chemical						Nitrates
A. Toxicity/Persistence	0 3 6 9 12 15 18	6	1	6	18	
B Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	2	1	2	8	Estimated 41-250 drums
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	7	1	7	26	Total uranium 156 pCi/l
B. Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine with available data
TOTAL WASTE CHARACTERISTICS SCORE.						
CHEMICAL				8	26	
RADIOACTIVE				7	26	
5. TARGETS						Drinking water use, alternate source available,
A. Groundwater Use	0 1 2 3	2	3	6	9	
B Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	12	1	12	40	Nearest Well 1-2 miles
TOTAL TARGETS SCORE				18	49	
6 CALCULATION						
If Line 1 is 45 Multiply 1 x 4 x 5						
If Line 1 is 0, Multiply 2 x 3 x 4 x 5						
CHEMICAL				6480	57330	
RADIOACTIVE				5670	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 11

RADIOACTIVE Sgw = 10

SITE: Low Priority, Inactive SWMU Group H

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTIPLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE If Observed Release is Given a Score of 45 Proceed to Line 4 If Observed Release is Given a Score of 0, Proceed to Line 2	0 45	45	1	45	45	Nitrates detected in groundwater
2. ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3		2		6	
B Net Precipitation	0 1 2 3		1		3	
C. Permeability of the Unsaturated Zone	0 1 2 3		1		3	
D Physical State	0 1 2 3		1		3	
TOTAL ROUTE CHARACTERISTICS SCORE					15	
3 CONTAINMENT	0 1 2 3		1		3	
4 WASTE CHARACTERISTICS						Toxicity 3, persistence 3 - beryllium
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	
B Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	71	1	71	8	5,000 to 10,000 drums
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	7	1	7	26	Total uranium 156 pCi/l
B Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine maximum potential with available data
TOTAL WASTE CHARACTERISTICS SCORE.						
CHEMICAL				25	26	
RADIOACTIVE				7	26	
5 TARGETS						
A. Groundwater Use	0 1 2 3	2	3	6	9	Drinking water use, available,
B Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	12	1	12	40	Nearest well 1-2 miles
TOTAL TARGETS SCORE				18	49	Population 190
6 CALCULATION If Line 1 is 45 Multiply 1 x 4 x 5 If Line 1 is 0 Multiply 2 x 3 x 4 x 5						
CHEMICAL				20250	57330	
RADIOACTIVE				5670	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 35

RADIOACTIVE Sgw = 10

SITE Low Priority, Inactive SWMU Group I

GROUNDWATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTIPLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE	0 45	0	1	0	45	Carbon tetrachloride not detected in groundwater
If Observed Release is Given a Score of 45 Proceed to Line 4						
If Observed Release is Given a Score of 0, Proceed to Line 2						
2. ROUTE CHARACTERISTICS						
A. Depth to Aquifer of Concern	0 1 2 3	3	2	6	6	Depth 0 to 20 feet
B Net Precipitation	0 1 2 3	0	1	0	3	Net ppt <-10 inches
C. Permeability of the Unsaturated Zone	0 1 2 3	3	1	3	3	Highly permeable
D Physical State	0 1 2 3	3	1	3	3	Liquid
TOTAL ROUTE CHARACTERISTICS SCORE				12	15	
3 CONTAINMENT	0 1 2 3	2	1	2	3	
4 WASTE CHARACTERISTICS						Toxicity 3, Persistence 3-tetrachloride,
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	
B Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	1	1	8	1-40 drums
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	7	1	7	26	Total uranium 156 pCi/l
B. Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine with available data
TOTAL WASTE CHARACTERISTICS SCORE.						
CHEMICAL				19	26	
RADIOACTIVE				7	26	
5 TARGETS						
A. Groundwater Use	0 1 2 3	2	3	6	9	Drinking water use with alternate source available
B. Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	12	1	12	40	Nearest well 1-2 miles Population 190
TOTAL TARGETS SCORE				18	49	
6. CALCULATION						
If Line 1 is 45 Multiply 1 x 4 x 5						
If Line 1 is 0, Multiply 2 x 3 x 4 x 5						
CHEMICAL				8208	57330	
RADIOACTIVE				3024	57330	

7 DIVIDE Line 6 by 57330 and Multiply by 100

CHEMICAL Sgw = 14

RADIOACTIVE Sgw = 5

SITE. Low Priority, Inactive SWMU Group J

SURFACE WATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTIPLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2	0 45	45	1	45	45	Nitrates and tritium in seepage from hillside north of ponds
2. ROUTE CHARACTERISTICS						
A. Facility Slope and Intervening Terrain	0 1 2 3		1		3	
B. 1/Yr 24-hr Rainfall	0 1 2 3		1		3	
C. Distance to Nearest Surface Water	0 1 2 3		2		6	
C. Physical State	0 1 2 3		1		3	
TOTAL ROUTE CHARACTERISTICS SCORE					15	
3. CONTAINMENT	0 1 2 3		1		3	
4 WASTE CHARACTERISTICS						Toxicity 3, Persistence 3-tetrachloroethylene
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	
B Hazardous Waste Quantity	0 1 2 3 4 5	8	1	8	8	Quantity unknown, worst case assumed
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	3	1	3	26	Tritium 1100 pCi/l, 21 pCi/l uranium
B Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	Cannot determine with available data
TOTAL WASTE CHARACTERISTICS SCORE						
CHEMICAL				26	26	
RADIOACTIVE				3	26	
5. TARGETS						Great Western Reservoir water supply for Broomfield 2,000 feet to 1 mile away
A. Surface Water Use	0 1 2 3 9	3	3	9	9	
B. Distance to Sensitive Environment	0 1 2 3	0	2	0	6	
C. Population Served/Distance to Water Intake Downstream	0 4 6 8 10 12 16 18 20 24 30 32 35 40	35	1	35	40	Population served greater than 10,000
TOTAL TARGETS SCORE				44	55	
6. CALCULATION If Line 1 is 45 Multiply 1 x 4 x 5 If Line 1 is 0 Multiply 2 x 3 x 4 x 5						
CHEMICAL				51480	64350	
RADIOACTIVE				5940	64350	

7 DIVIDE Line 6 by 64350 and Multiply by 100

CHEMICAL Ssw = 80

RADIOACTIVE Ssw = 9

SITE: Low Priority, Inactive SWMU Group A & B

SURFACE WATER ROUTE WORKSHEET

RATING FACTOR	VALUE RANGE	SEL VAL	MULTI-PLIER	SCORE	MAX SCORE	ASSUMPTIONS FOR EACH ASSIGNED SCORE
1 OBSERVED RELEASE If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2	0 45	45	1	45	45	Plutonium detected in surface water
2. ROUTE CHARACTERISTICS						
A. Facility Slope and Intervening Terrain	0 1 2 3		1		3	
B 1/Yr 24-hr Rainfall	0 1 2 3		1		3	
C Distance to Nearest Surface Water	0 1 2 3		2		6	
C. Physical State	0 1 2 3		1		3	
TOTAL ROUTE CHARACTERISTICS SCORE					15	
3. CONTAINMENT	0 1 2 3		1		3	
4 WASTE CHARACTERISTICS						Toxicity 3, Persistence 3-tetrachloroethylene
Chemical						
A. Toxicity/Persistence	0 3 6 9 12 15 18	18	1	18	18	
B Hazardous Waste Quantity	0 1 2 3 4 5	8	1	8	8	Quantity unknown, worst case assumed
Radioactive						
A. Maximum Observed	0 1 3 7 11 15 21 26	1	1	1	26	8.4 pCi/l
B Maximum Potential	0 1 3 7 11 15 21 26	0	1	0	26	
TOTAL WASTE CHARACTERISTICS SCORE						
CHEMICAL				26	26	
RADIOACTIVE				1	26	
5. TARGETS						Surface water within 2-3 miles used for drinking water - Standley Lake
A. Surface Water Use	0 1 2 3 9	3	3	9	9	
B. Distance to Sensitive Environment	0 1 2 3	0	2	0	6	No sensitive environments
C. Population Served/Distance to Water Intake Downstream	0 4 6 8 10 12 16 18 20 24 30 32 35 40	20	1	20	40 55	Population served >10,000
TOTAL TARGETS SCORE						
6 CALCULATION If Line 1 is 45 Multiply 1 x 4 x 5 If Line 1 is 0, Multiply 2 x 3 x 4 x 5						
CHEMICAL				33930	64350	
RADIOACTIVE				1305	64350	

7 DIVIDE Line 6 by 64350 and Multiply by 100

CHEMICAL Ssw = . 52

RADIOACTIVE Ssw = 2

SITE· Low Priority, Inactive SWMU Group C

COMPREHENSIVE ENVIRONMENTAL ASSESSMENT AND RESPONSE PROGRAM

PHASE 3.
ROCKY FLATS PLANT

FEASIBILITY STUDY AND RISK ASSESSMENT PLANS

ROCKWELL INTERNATIONAL
AEROSPACE OPERATIONS

1 June 1988

DRAFT

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1. INTRODUCTION

This document provides a work plan for conducting CEARP Phase 3 feasibility studies at Rocky Flats Plant In addition, it contains a plan (Appendix A) for performing risk/endangerment assessments This Risk/Endangerment Assessment Plan addresses both public health and environmental concerns

CEARP Phase 2b remedial investigations and CEARP Phase 3 feasibility studies are interdependent Activities making up these two phases will be performed concurrently to the greatest extent possible CEARP Phase 2b remedial investigations will provide the data base for performing CEARP Phase 3 feasibility studies During CEARP Phase 3, alternative remedial actions will be developed and evaluated in terms of cost, feasibility of proposed engineering, extent of protection to public health and the environment, and environmental impacts during or remaining after implementation

The EPA has provided guidelines for preparing CEARP Phase 3 feasibility studies in *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988) The guidelines for detailed evaluations of alternatives and selection of recommended actions are intended for sites that fall under CERCLA feasibility study requirements Similar evaluations will be implemented on a site-by-site basis for CEARP sites at Rocky Flats Plant not meeting CERCLA feasibility study requirements, e g , inactive waste areas that do not meet the threshold for being listed on the National Priorities List (NPL) and RCRA solid waste management units Solid waste management units evaluated under CEARP Phase 3 feasibility studies must also meet appropriate requirements under RCRA, including the 1984 RCRA Hazardous and Solid Waste Amendments (HSWA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) The 1984 amendments established broad authorities in the RCRA program to required corrective action for releases of hazardous wastes and constituents at RCRA-regulated facilities, including

- corrective action for continuing releases (3004[u]),
- interim/status corrective action orders (3008[h]), and
- corrective action beyond the facility boundary (3004[v])

The 1986 Amendments added many requirements to activities at Superfund Sites, however, the basic framework remains intact The most significant emphasis is on risk reduction through destruction or detoxification of hazardous waste by employing treatment technologies that reduce toxicity, mobility, or volume rather than protection achieved through prevention of exposure SARA gives preference to remedies that use treatment to permanently and significantly reduce the toxicity, mobility, or volume of wastes over remedies that do not use such treatment In addition, SARA requires selection of a remedy that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable

EPA is developing a phased process for implementing the corrective action provisions of the 1984 and 1986 Amendments that consists of preliminary assessments/site investigations, remedial investigations, and implementation of corrective measures The phased approach used by CEARP for both CERCLA and RCRA continuing release sites at DOE-Albuquerque Operations Office installations is consistent with EPA guidance

2. REMEDIAL RESPONSE OBJECTIVES

The objectives of the CEARP Phase 3 feasibility studies at Rocky Flats Plant are to develop plans for remedial actions by proposing and assessing alternative technologies and approaches to eliminate or control environmental problems characterized by the CEARP Phase 2b remedial investigations The remedial actions will be defined according to the nature of the site and will address the necessity of source control measures (designed to prevent or minimize migration of hazardous substances from the source) and/or management-of-migration measures (designed to mitigate the impact of contamination that has migrated into the environment)

The guidelines that will be used to develop and screen alternative remedial actions are presented in detail in Sections 3 and 4, and those for detailed analysis of the alternatives are presented in Section 5 The framework for alternative remedial action selection is as follows

- a technical analysis of the alternative approaches in terms of performance, reliability, ease of implementation, and safety,
- an institutional analysis of the alternative remedial actions in terms of federal, state, or local standards, advisories, or guidelines that must be obtained or considered to protect public health and welfare, and the environment,
- an evaluation of public health exposure,
- an environmental analysis of alternative remedial actions, and
- a cost analysis of alternative remedial actions

The CEARP Phase 3 feasibility study will be integrated with the CEARP Phase 2 remedial investigations to ensure that alternatives are formulated and evaluated using site information CEARP Phase 3 feasibility study reports will provide documentation for Phase 3 of DOE CERCLA (DOE 5480 14), and two remedial planning program elements of EPA CERCLA/SARA (Feasibility Study and Remedial Action Selection)

3 HEALTH ASSESSMENTS

The Agency for Toxic Substances and Disease Registry (ATSDR) shall perform a health assessment for each facility at Rocky Flats These health assessments shall include an analysis of the existence of potential pathways of human exposure, the size and potential susceptibility of the community within the likely pathways, and a comparison of exposure to recommended exposure or tolerance limits The purpose of the assessment is to help determine whether actions should be taken to reduce human exposure to hazardous substances at the facility and to determine whether additional testing or health surveillance is required ATSDR must complete its health assessment before completion of the feasibility study in order that the feasibility study for the site can take the assessment into consideration in evaluating remedial action options

4. PRELIMINARY ALTERNATIVE REMEDIAL ACTIONS DEVELOPMENT

The first step of the CEARP Phase 3 feasibility studies will be to identify general response actions and alternative remedial actions for each site This will be accomplished by a technology identification and screening procedure that consists of five steps

1 Identifying CEARP sites and associated problems, including pathways for migration of contamination (CEARP Phases 1 and 2)

2 Identifying general response actions and associated remedial technologies that address site problems and meet clean-up goals and objectives (CEARP Phase 3)

3 Identifying Applicable or Relevant and Appropriate Requirements

4 Screening the technologies to eliminate inapplicable and infeasible technologies based on site conditions (CEARP Phase 3)

5 Developing alternative remedial actions

Developing and screening technologies (and alternatives) is an iterative process taking place in CEARP Phases 2 and 3 This process will begin during Phase 2 remedial investigations to define the field data and pilot study requirements of specific technologies and alternative remedial actions As more site data are collected, existing technologies and alternative remedial actions may be rescreened, or additional remedial actions developed, to better address the revised objectives resulting from a refined understanding of the site

4.1 GENERAL RESPONSE ACTIONS AND REMEDIAL TECHNOLOGY IDENTIFICATION

General response actions and associated remedial technologies have been identified for sites at Rocky Flats Plant They are listed in Table 4 1 The list of general response actions may change or combinations of two or more be used at one site These determinations will be made as data from the remedial investigations become available. The list of general response actions is adapted from EPA's

Table 4 1 General Response Actions and Associated Remedial Technologies

General Response Action	Typical Technologies
No Action	Some monitoring and analyses may be performed
Containment	Capping, groundwater containment barrier walls, bulkheads, gas barriers
Pumping	Groundwater pumping, liquid removal, dredging
Collection	Sedimentation basins, French drains, gas vents, gas collection systems
Diversion	Grading, dikes and berms, stream diversion ditches, trenches, terraces and benches, chutes and downpipes, levees, seepage basins
Complete Removal	Tanks, drums, soils, sediments, liquid wastes, contaminated structures, sewers and water pipes
Partial Removal	Tanks, drums, soils, sediments, liquid wastes
Onsite Treatment	Incineration, solidification, land treatment, biological, chemical, and physical treatment
Offsite Treatment	Incineration, biological, chemical, and physical treatment
<u>In Situ</u> Treatment	Permeable treatment beds, bioreclamation, soil flushing, neutralization, land farming
Storage	Temporary storage structures
Onsite Disposal	Landfills, land application
Offsite Disposal	Landfills, surface impoundments, land application

Source EPA 1985a

"Guidance on Feasibility Studies under CERCLA," (EPA 1985a) and the 1986 SARA Amendments Two general response actions, alternate water supply and relocation of potentially affected populations, have been eliminated for the present because the preliminary assessment (CEARP Phase 1) found that the concentrations of hazardous constituents outside the installation boundaries were below EPA guideline concentrations (DOE 1986b)

Remedial technologies that will be used for developing response actions are listed in Table 4 2 As information from the remedial investigations becomes available, it will be reviewed to determine if conditions exist that limit or promote the use of certain remedial technologies Permanent solutions requiring a minimum of maintenance and monitoring will be preferred

4 2 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Under the Superfund Amendments and Reauthorization Act of 1986 (SARA), remedial actions must comply with applicable or relevant and appropriate requirements (ARARs) of Federal laws and the more stringent state laws State requirements must be evaluated and defined according to existing chemical, location, and action-specific criteria The requirements defined as an ARAR are those that are applicable or relevant and appropriate to the hazardous substances, pollutants, or contaminants that remain on site or to the circumstances of the site-specific release

Applicability implies that the remedial action or the circumstances at the site satisfy all of the jurisdictional prerequisites of a requirement For example, the minimum requirement for ground water contaminated with benzene may be defined as the more stringent of the Federal Maximum Contaminant Levels (MCLs) or any applicable action levels defined by state requirements for benzene in ground water Relevant and appropriate requirements are established by evaluating a number of factors, including the types and quantities of contaminants, the physical circumstances of the site, and the characteristics of the remedial actions that may be

Table 4 2 Remedial Technologies

A **Air Pollution Controls**

-- Capping
  - Synthetic membranes
    - Clay
    - Asphalt
    - Multimedia cap
    - Concrete
    - Chemical sealants/stabilizers
-- Dust Control Measures
    - Chemical fixatives
    - Water

B **Surface Water Controls**

-- Capping (see A)
-- Grading
    - Scarification
    - Tracking
    - Contour furrowing
-- Revegetation
    - Grasses
    - Legumes
    - Shrubs
    - Forbs
    - Trees
-- Diversion and Collection Systems
    - Dikes and berms
    - Ditches and trenches
    - Terraces and benches
    - Chutes and downpipes
    - Seepage basins
    - Sedimentation basins and ponds
    - Levees
    - Addition of freeboard
    - Floodwalls

Table 4 2 (Continued)

Leachate and Groundwater Controls

-- Capping (see A)
-- Containment Barriers
  Function Options
  - Downgradient placement
  - Upgradient placement
  - Circumferential placement
  Material and Construction Options (vertical barriers)
  - Soil-bentonite slurry wall
  - Cement-bentonite slurry wall
  - Vibrating beam
  - Grout curtains
  - Steel sheet piling
  Horizontal Barriers (bottom sealing)
  - Block displacement
  - Grout injection
  - Liners
-- Groundwater Pumping (generally used with capping and treatment)
  Function Options
  - Extraction and injection
  - Extraction alone
  - Injection alone
  Equipment and Material Options
  - Well points
  - Deep wells
  - Suction wells
  - Ejector wells
-- Subsurface Collection Drains
  - French drains
  - Tile drains
  - Pipe drains (dual medial drains)

D Gas Migration Controls (generally used with treatment)

-- Capping (gas barriers) (see A)
-- Gas Collection and/or Recovery
  - Passive pipe vents
  - Passive trench vents
  - Active gas collection systems

Table 4 2 (Continued)

Excavation and Removal of Waste and Soil

-- Excavation and Removal
  - Baekhoe
  - Cranes and attachments
  - Front-end loaders
  - Scrapers
  - Pumps
  - Industrial vacuums
  - Drum grapplers
  - Forklifts and attachments
-- Grading (see B)
-- Capping (see A)
-- Revegetation (see B)

F Removal and Containment of Contaminated Sediments

-- Sediment Removal
  Mechanical Dredging
  - Clamshell
  - Dragline
  - Backhoe
  Hydraulic Dredging
  - Plain suction
  - Cutterhead
  - Dustpan
  Pneumatic Dredging
  - Airlift
  - Pneuma
  - Oozer
-- Sediment Turbidity Controls and Containment
  - Curtain barriers
  - Coffer dams
  - Pneumatic barriers
  - Capping

G In Situ Treatment

-- Chemical Treatment
-- Soil Aeration
-- Solvent Flushing
-- Bioreclamation
-- Permeable Treatment Beds

Table 4.2 (Continued)

Direct Waste Treatment

-- Incineration
  - Rotary kiln
  - Fluidized bed
  - Multiple hearth
  - Liquid injection
  - Molten salt
  - High temperature fluid wall
  - Plasma arc pyrolysis
  - Cement kiln
  - Pyrolysis/starved combustion
  - Wet air oxidation
  - Industrial boiler or furnace

-- Gaseous Waste Treatment
  - Activated carbon
  - Flares
  - Afterburners

-- Treatment of Aqueous and Liquid Waste Streams

  Biological Treatment
  - Activated sludge
  - Trickling filters
  - Aerated lagoons
  - Waste stabilization ponds
  - Rotating biological disks
  - Fluidized bed bioreactors

  Chemical Treatment
  - Neutralization
  - Precipitation
  - Oxidation
  - Hydrolysis
  - Reduction
  - Chemical dechlorination
  - Ultraviolet/ozonation

  Physical Treatment
  - Flow equalization
  - Flocculation
  - Sedimentation
  - Activated carbon
  - Oil adsorption media
  - Ion exchange
  - Reverse osmosis
  - Liquid-liquid extraction
  - Oil-water separator
  - Steam distillation
  - Air stripping

Table 4 2 (Continued)

- Steam stripping
- Filtration
- Dissolved air flotation

Discharge to Publicly-Owned Treatment Works

-- Handling and Treatment of Solids

Dewatering
- Screens, hydraulic classifiers, scalpers
- Centrifuges
- Gravity thickening
- Flocculation, sedimentation
- Belt filter presses
- Drying or dewatering beds
- Vacuum-assisted drying beds

Treatment
- Neutralization
- Solvent
- Oxidation
- Reduction
- Composting

-- Solidification, Stabilization, or Fixation
- Cement-based
- Lime-based
- Thermoplastic
- Organic polymer
- Self-cementing techniques
- Surface encapsulation
- Gassification
- Solidification (i e, to fly ash, polymers, sawdust)

I <u>Land Disposal Storage</u>

-- Landfills
-- Surface Impoundments
-- Land Application
-- Waste Piles
-- Deep Well Injection
-- Temporary Storage

J <u>Contaminated Water Supplies and Sewer Lines</u>

-- *In situ* Cleaning
-- Removal and Replacement
-- Alternative Drinking Water Supplies
- Cisterns or tanks
- Deeper or upgradient wells
- Municipal water systems
- Relocation of intake
-- Individual Treatment Units

implemented Relevant and appropriate requirements are applied to the same degree as applicable requirements

Although states are required by SARA to identify ARARs in a timely manner, there presently exists a limited number of applicable chemical-specific requirements In order to define relevant and appropriate requirements for a particular constituent and site, a risk assessment, migration pathway analysis, and/or a bench-scale study specific to a particular site or constituent may be required More often than not, relevant and appropriate requirements may be based on regulatory guidelines, accepted practice, or advisory levels that define hazardous substances or conditions, but do not define specific cleanup levels

4 3 SCREENING REMEDIAL TECHNOLOGIES

Technology screening is the first phase of a three-phase process involved in the selection of the remedial approach that best satisfies remedial objectives, complies with regulations, and meets established ARARs The screening process eliminates unfeasible, inappropriate, or environmentally unacceptable technologies according to the following criteria

- compliance with ARARs,
- ability to significantly reduce toxicity, mobility, and volume,
- short-term effectiveness,
- long-term effectiveness and permanence,
- implementability,
- time requirements,
- cost,
- community reaction,
- state acceptance;
- overall protection of human health and the environment

The above criteria should be applied to any technology during the initial screening process According to SARA regulations, the protection of human health and the environment is emphasized The overall ability to implement a technology at a particular site is a key concern

4 4 ALTERNATIVE REMEDIAL ACTION DEVELOPMENT

Alternative remedial actions will be identified that fit into one of the five general categories listed in the NCP, and additional options as required by SARA These categories are as follows

- Alternative remedial actions in which on-site treatment permanently and significantly reduces the need for long term management, including monitoring, at site,
- An alternative remedial action that reduces the volume of the waste, not just the toxicity or mobility,
- A containment option involving little or no treatment,
- Alternative remedial actions for offsite treatment or disposal at a facility approved by EPA (including RCRA, TSCA, CWA, CAA, MPRSA, and SDWA approved facilities), as appropriate,
- Alternatives that meet the CERCLA goals of preventing or minimizing present or future migration of hazardous substances and protection of public health and the environment, but do not attain all of the applicable or relevant and appropriate requirements (ARARs),
- Alternative remedial actions that attain all applicable relevant and appropriate Federal and State public health or environmental standards,
- Alternative remedial actions that exceed all applicable relevant and appropriate Federal and State public health or environmental standards, and
- A "no action" alternative

4 5 IDENTIFICATION OF POTENTIAL OPERABLE UNITS

The sites at Rocky Flats Plant will be combined, as appropriate, for the necessary CEARP Phase 2b remedial investigations Initially, these groupings of solid waste management units will be treated as independent areas when considering remedial actions However, in some cases, the individual solid waste management units will contain different constituents Remedial actions that address individual sites may be appropriate

An operable unit is defined by EPA as "a discrete part of a remedial action that can function independently as a unit and contributes to preventing or minimizing a release or threat of release" (EPA 1985a) Individual operable units will be considered if the remedial action is compatible with the long-term solutions under consideration for Rocky Flats Plant Individual operable units will also be considered if there is an immediate threat to human health or the environment

5. ALTERNATIVE REMEDIAL ACTION SCREENING

The alternative remedial actions identified will be screened to narrow the range of potential considerations The factors considered when screening include the permanence of solution, technical feasibility and reliability, performance criteria related to environmental and public health and safety, and cost of implementation and operation Security requirements may make a remedial action at a site impractical or difficult to implement Therefore, in those areas where security is a concern, security requirements will drive the screening process

The screening process will eliminate remedial actions that are not technically feasible, that do not adequately protect public health and welfare and the environment, or that are much more costly and yet do not provide significantly greater protection The rationale for excluding each inadequate remedial action will be documented

In some situations, screening may eliminate all remedial actions in one of the seven categories listed in Section 4 1, "Alternative Remedial Action Identification" If this occurs, at least one remedial action for the category that was eliminated will be included in the Feasibility Study Report described in Section 7 with an explanation as to why it was eliminated at the screening stage

5 1. TECHNICAL FEASIBILITY SCREENING

Remedial actions will be evaluated based on performance, reliability, and implementability Remedial actions that are not based on proven technology or are not compatible with site and waste source conditions, including those that might be difficult to construct under existing site conditions, will be eliminated Innovative technologies will be considered if they are based on sound principles

5.2. ENVIRONMENTAL, PUBLIC HEALTH, AND INSTITUTIONAL SCREENING

The purpose of this screening criteria is to eliminate alternatives that do not adequately protect the environment or public health and welfare Remedial actions will be evaluated to see if implementation may cause a threat to public health or the environment (e g, possible exposure from contaminated soil associated with excavation activities) Remedial actions will also be reviewed to assess the effect that compliance with institutional issues will have on the implementation of that alternative

5 3 COST SCREENING

Costs for implementing the various remedial actions will be developed and cost screening conducted after the technical feasibility and environmental/public health/institutional screenings have been performed Cost effectiveness of remedial actions will only be considered after appropriate levels of cleanup have been met at a particular site Cost will be most important in deciding between alternatives that provide similar levels of protection of human health and the environment Cost will be less important when deciding between alternatives giving different levels of protection

Screening of remedial action costs will be based on both capital and operating and maintenance (O&M) costs These costs will be estimated using the following resources

- *Remedial Actions Cost Compendium* (ELI 1984),
- *Handbook Remedial Action at Waste Disposal Sites* (EPA 1985),
- Rocky Flats Plant Cost Estimating Group, and
- Standard cost indices

After developing screening cost data, a present worth analysis will be performed Details on methods and procedures to be used for cost estimation and present worth analysis are discussed in "Guidance for Conducting Remedial Investigations and Feasibility Studies" (EPA, 1988) and in the EPA Remedial Action Costing Procedures Manual (EPA 1983)

Remedial actions with excessive costs that do not provide significantly greater protection to the environment or public health and welfare will be eliminated Remedial actions that are found to be more expensive but that offer substantially greater environmental or public health and welfare benefits will remain under consideration On-site remedial actions that permanently and significantly reduce the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants will be considered over other less expensive technologies that provide similar levels of protection of human health and the environment The latter shall be the remedial action of preference, provided the on-site permanent remedial action is not more than three times more expensive than the less expensive technologies providing similar levels of protection of human health and the environment

6. REMEDIAL ACTION ANALYSIS

6.1. DETAILED DEVELOPMENT OF FEASIBLE REMEDIAL ACTIONS

The descriptions of the remedial actions that remain after the initial screening will be further developed to include, but not be restricted to, the following

- a description of the permanence of the solution and the reduction in the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants The offsite transport and disposal of hazardous substances or contaminated material shall be the least favored technology where practicable treatment technologies are available,

- a description of appropriate treatment and disposal technologies, as well as any required permanent facilities,

- specific engineering considerations required to implement the remedial action (e g, pilot treatment facilities, and additional studies needed to proceed with final remedial action design),

- environmental impacts and proposed methods for mitigating any adverse effects,

- operation and maintenance/monitoring requirements of the completed remedy,

- offsite disposal needs and transportation plans,

- requirements for safety plans to be followed during remedial action implementation (including both onsite and offsite health and safety considerations),

- a description of how the remedial action may be segmented to allow staged implementation Both staging and segmenting options will be developed in close consultation with the EPA and Colorado Department of Health (CDH),

- a review of any offsite treatment or disposal facilities to ensure compliance with applicable CERCLA and/or RCRA requirements and EPA policy,

- a determination of what permits would be necessary for each alternative identified and what information is necessary for issuance of these permits,

- the extent to which the remedial actions meet technical requirements and standards of applicable relevant and appropriate environmental

- the extent to which the remedial actions meet technical requirements and standards of applicable relevant and appropriate environmental regulations this information should be arrayed so that differences among the remedial actions, in terms of how they satisfy such standards, are readily apparent The kinds of standards applicable at the site may include (1) CERCLA and/or RCRA design and operating standards, (2) drinking water standards, and (3) environmental discharge standards,

- community effects The types of information that should be provided include (1) the extent to which implementing a remedial action would disrupt the community (e g, traffic, temporary health risks, and relocation) and (2) the likely public reaction, and

- any solutions that leave contamination in place of onsite require review every five years to determine whether additional action is appropriate

6 2 TREATABILITY STUDIES

Laboratory and bench scale treatability studies may be necessary to establish the effectiveness of the remedial actions and to develop engineering criteria A detailed plan for treatability studies will be prepared as needed on a site-specific basis and incorporated into the CEARP Phase 3 feasibility studies as appropriate

Several treatability studies have already been performed on soil decontamination methods at Rocky Flats Plant The studies available are as follows

- Soil Decontamination at Rocky Flats (Olsen et al 1980)

- Separation of Transuranic Radionuclides from Soil by Vibratory Grinding (Stevens et al 1982a)

- Comparative Scrub Solution Tests for Decontamination of Transuranic Radionuclides from Soils (Stevens et al 1982b)

- Waste Generation Reduction - Nitrates, Comprehensive Report of Denitrification Technologies (Johnson et al 1986)

6.3 REMEDIAL ACTION ASSESSMENT

Remedial actions will be evaluated in detail on the basis of technical feasibility, protection afforded to public health and the environment, institutional requirements, and cost The major concern in a detailed evaluation of remedial actions is that the remedial action be appropriate to site conditions

6 3 1 Technical Analysis

The technical analysis will include an evaluation of the performance of the remedial action, its reliability, its implementability in terms of demonstrated success at a similar site or on a research and development basis, the effectiveness of the option in achieving safety requirements, and the ability of the remedial action to achieve a permanent solution

Remedial actions will be evaluated in terms of performance Any special site or waste conditions that affect performance will be considered, and the preliminary design will be tailored to accommodate those conditions The evaluation will also consider the effectiveness of combining technologies

Each remedial action will also be evaluated in terms of the projected service life of its component technologies Resource availability in the future life of the technology, as well as the appropriateness of the technology, will be considered in estimating the useful life of the project

The cost to install and operate remedial actions coupled with the need to protect public health and the environment make reliability a serious concern Technologies that require frequent or complex operations and maintenance activities will be regarded as less reliable than technologies requiring little or straightforward operation and maintenance

The technical analysis of remedial actions will not be based on the presumed performance of untested methods An estimate of the probability of failure, in either qualitative or quantitative terms, will be made for each component technology and for the complete alternative Preference will be given to technologies that have proven effective under waste and site conditions similar to those anticipated However, innovative or advanced technology will be evaluated as an alternative to conventional technology, if appropriate If such technology is included in suggested remedial actions, information from research supporting its use and expected reliability will be documented

Each remedial action will be evaluated with regard to safety This evaluation will include short-term and long-term threats to the safety of nearby workers, residents, and environs, as well as threats to workers during implementation Major risks that will be considered are fire, explosion, and exposure to hazardous substances resulting from both onsite and offsite work while the remedial action is being implemented

6 3 2 Risk/Endangerment Assessment

Appendix A is the risk/endangerment assessment plan Key components of the risk/endangerment assessment are summarized here

Using the "no action" alternative as a baseline, a comparative analysis will be performed on the other remedial actions This analysis will include an evaluation of the extent to which the remedial actions can be expected to mitigate, minimize damage to, and protect public health and welfare, and the environment The evaluation will include an analysis of the extent and duration of exposure to contaminants and a comparison of contaminant concentrations to appropriate ambient standards and criteria Certain actions may not necessarily produce a reduction in risk, particularly during the short-term remedial action period (e g , removal and offsite disposal of contaminated soils may create an additional exposure pathway)

The environmental assessment will address both the long-term and short-term effects of the remedial action under consideration The level of detail will depend on the degree of potential impact

The public health evaluation will consist of the following

- a baseline site evaluation to provide a preliminary assessment of the public health risks,
- an exposure assessment to analyze the extent and duration of human exposure to site contaminants in the absence of remedial action,
- a standards analysis to compare projected environmental concentrations to appropriate ambient standards or criteria, and

- an evaluation to assess the short- and long-term effects and the efficiency of the proposed remedial action with respect to removal or mitigation exposures identified during the exposure assessment

6 3 3 Institutional Analysis

This analysis will entail an evaluation of the effect of permit requirements, regulatory agency acceptance, and government infrastructure requirements on implementation of the remedial action

6 3 4 Cost Analysis

After appropriate levels of cleanup or treatment have been established by the Risk Assessment, a cost analysis will be conducted Cost will be a more important factor when comparing alternatives which provide similar results, cost will be a less important factor when comparing alternatives that provide different levels of treatment

The cost analysis will involve the development of a present worth analysis for each remedial alternative The analysis will include

- capital cost
- annual operation and maintenance cost
- present worth cost

In addition, a sensitivity analysis will be performed to evaluate risks and uncertainties in cost estimates

7. COMPARATIVE EVALUATION OF ACCEPTABLE ALTERNATIVES

Following the remedial action assessment, a comparative evaluation of acceptable remedial actions will be performed This evaluation will include developing the relative importance of both cost and noncost criteria Based on these factors and the alternative assessments, each remedial action will be ranked so that key differences will be evident Remedial actions that attain or exceed the requirements of applicable relevant and appropriate environmental regulations will be identified The comparative evaluation will utilize the detailed information collected during remedial investigations and will support a remedial action recommendation

The remedial action for a site should be selected among those alternatives about which the following four findings can be made

- Remedies must be protective of human health and the environment This means that the remedy meets or exceeds ARARs or health-based levels established through a risk assessment when ARARs do not exist

- Remedies should attain Federal and State public health and environmental requirements that have been identified for a specific site In general, the remedy selection process presumes that alternatives will be formulated and refined to ensure that they attain all of the appropriate ARARs However, SARA does provide waivers which permit selection of remedies which do not attain all ARARs under six different types of circumstances fund-balancing, technical impracticability, interim remedy, greater risk to health and the environment, equivalent standard of performance, and inconsistent application of State standards If a remedy is protective, cost-effective, and adequately satisfies the statutory preferences, inability to attain a particular ARAR will not necessarily prevent selection of that alternative if it was viewed as the all around best remedial alternative

- Remedies must be cost-effective In general, this finding requires ensuring that the results of a particular alternative cannot be achieved by less costly methods This implies that for any specific site there may be more than one cost-effective remedy, with each remedy varying in its environmental and public health results

- Remedies must utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable This determination is interrelated to the cost-effectiveness finding and includes consideration of technological feasibility and availability

The selected remedy should represent the best balance across all the effectiveness, implementability, and cost factors examined in the detailed analysis In making this selection, the decision-maker must consider the statutory preference for treatment which permanently and significantly reduces the toxicity, mobility, or volume of the waste

8. CEARP PHASE 3 FEASIBILITY STUDY REPORT

A CEARP Phase 3 feasibility study report will be prepared that will document the remedial actions considered and explain why each option was eliminated both in preliminary screening and detailed analysis A description of the recommended remedial action will be included that will cover the following

- a review of what the remedial action will and will not accomplish,
- a review of how the remedial action addresses the requirements and the intent of the NCP (e g, placing emphasis on a permanent remedy to the identified site problem(s) utilizing innovative technologies),
- a review of the permanence of the solution,
- special engineering considerations and special studies needed during the final design,
- operation, maintenance, and monitoring requirements,
- offsite disposal needs and transportation plans, if appropriate,
- temporary storage requirements, if appropriate,
- regulatory permit requirements, if appropriate,
- brief descriptions of the environmental and public health problems that may be encountered during implementation, and
- means of mitigating the associated environmental and public health problems (and their costs), and how identified/determined environmental standards are being met

At a minimum, CEARP Phase 3 reports will follow guidelines presented in DOE Order 5480 14 as follows

1 Executive Summary
2 Criteria
3 Evaluation of Remedial Action Alternatives
4 Recommended Remedial Action (Project Proposal)
5 Resource Requirements
6 Proposed Schedule

Additionally, CEARP Phase 3 documentation will be responsive to pertinent elements of EPA Feasibility Study reporting requirements This documentation must be consistent with requirements under NEPA and other environmental regulations, DOE Order 5440 1C and AL Order 5440 1B, and the DOE *Environmental Compliance Guide* (DOE 1981)

9. REFERENCES

DOE 1981 "Environmental Compliance Guide," US Department of Energy report DOE/EV-0132, February 1981

DOE 1986b "Comprehensive Environmental Assessment and Response Program Phase 1 Draft Installation Assessment Rocky Flats Plant," US Department of Energy unnumbered draft report, April 1986

DOE 1986d "Comprehensive Environmental Assessment and Response Program Phase 3 Technological Assessment Plan," U S Department of Energy, Albuquerque Operations Office unnumbered report, August 1986

DOE 1986f "Resource Conservation and Recovery Act Part B - Operating Permit Application for USDOE Rocky Flats Plant, Hazardous and Radioactive Mixed Wastes," US Department of Energy unnumbered report, November 1986

DOE 1986g "Resource Conservation and Recovery Act Part B - Post-Closure Care Permit Application for USDOE Rocky Flats Plant, Hazardous and Radioactive Mixed Wastes," US Department of Energy unnumbered report, November 1986

ELI 1984 "Remedial Action Cost Compendium," Environmental Law Institute unnumbered report, 1984

EPA 1983 Remedial Action Costing Procedures Manual, U S Environmental Protection Agency report, 1983

EPA 1985b "Handbook Remedial Action at Waste Disposal Sites," US Environmental Protection Agency report EPA-625/6-85-006, Office of Emergency and Remedial Response, Washington, D C , 1985

EPA 1986 "Interim Guidance on Superfund Selection of Remedy," U S Environmental Protection Agency, Directive Number 9355 0-19, Office of Solid Waste and Emergency Response, Washington, D C , 1986

EPA 1988 "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA," Office of Emergency and Remedial Response, Office of Solid Waste and Emergency Response, United States Environmental Protection Agency, OSWER Directive 9335 3-01, Draft, March 1988

Johnson 1986 Johnson, A J, et al, "Waste Generation Reduction - Nitrates, Comprehensive Report of Denitrification Technologies," US Department of Energy unnumbered report, 1986

Olsen 1980 Olsen, R L, et al, "Soil Decontamination at Rocky Flats," Decontamination and Decommissioning of Nuclear Facilities, Plenum Publishing Corporation, 1980

Stevens 1982a Stevens, J R and D W Rutherford, "Separation of Transuranic Radionuclides from Soil by Vibratory Grinding," US Department of Energy report, 1982

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APPENDIX A

RISK/ENDANGERMENT ASSESSMENT PLAN

1. INTRODUCTION

1.1. BACKGROUND

This Risk/Endangerment Assessment Plan documents a conservative approach for determining the upper boundary of risk to the "maximally exposed" and "average exposed" individual associated with present contamination at Rocky Flats Plant It is designed to identify risks that could be incurred from a particular site if the "no action" plan were taken, plus feasible remedial actions The technical direction for the performance of this study comes from several sources, including *Guidance on the Performance of Endangerment Assessments (EPA 1985), Handbook of Endangerment Assessments (EPA 1985), and The Superfund Public Health Evaluation Manual (EPA 1986)*

Risk estimates will be dependent on assumptions about the mechanisms of contamination release, dispersion, and pathways by which contaminants may be inhaled, ingested, or absorbed by the population surrounding the site, and the health effects caused by exposure to these substances

Risk to public health is a function of several factors In order for chemicals to pose a risk, two factors must exist simultaneously The substance must be toxic to a particular receptor at a specified concentration and there must be some chance that an individual can come into contact with a sufficient amount of the toxic substance

The risk/endangerment assessment will address the toxicity and amounts of substances released at Rocky Flats Plant, and the chance and degree of human exposure Existing data will be used to assess risk All data collected under the CEARP site characterizations (remedial investigations) will be included Additional data will be collected if warranted

1.2. REQUIREMENTS

Stringent requirements are necessary to provide an unbiased risk/endangerment assessment

These requirements are as follows

- an unbiased comprehensive investigation with no preconceptions as to the significance of individual sources,
- a series of decision points to evaluate progress and, if necessary, redirect efforts on an iterative basis,
- definitive conclusions that support the selection of an alternative remedial action, and
- a well documented Quality Assurance Program

1 2 1 Quality Assurance and Quality Control Considerations

When errors in sampling, preservation, or analytical method execution are identified, results will be rejected following the guidance provided in the IGMP/CSPCP Quality Assurance/Quality Control Plan

1 2 2 Exposed Population Analysis

The analysis of potential exposure to contamination will address both onsite and offsite populations Employees have executed waivers of liability to work at DOE-Albuquerque Operations Office facilities, however, these work forces are being included in the risk/endangerment assessments following the guidance provided in the DOE CERCLA order (DOE Order 5480 14)

2 TECHNICAL WORK PLAN

2 1. OVERVIEW

The objective of this risk assessment is to determine if potential harm to public health and the environment is posed by release of hazardous substances from Rocky Flats Plant An assessment will be made for the plant as a whole and for solid waste management units as appropriate This will be accomplished by identifying and characterizing the following data.

- hazardous substances and/or wastes present in all relevant media (e g , air, surface water, sediment, groundwater, and soil),
- environmental fate and transport mechanisms within specified environmental media (e g , chemical and biological degradation processes),
- exposure pathways and extent of expected exposure,
- populations at risk,
- intrinsic toxicological properties of specified hazardous substances, and
- extent of expected harm and the likelihood of such harm occurring (i e , risk characterization)

The risk/endangerment assessment process will have five separate components

- contamination characterization
- environmental fate and transport assessment
- exposure assessment
- toxicity assessment
- risk characterization

A brief description of the major technical components of the risk assessment are discussed below Figure B 1 provides a schematic of the risk assessment process and the relationship of its components

2.2. CONTAMINATION CHARACTERIZATION

The purpose of the contamination characterization is to provide a framework for establishing background descriptions and contamination history It identifies and quantifies the contaminants present at the site "Contaminants of Concern" (those that best represent the range of physiochemical and toxicological properties) will be selected during the contamination assessment

Objective Determine the extent and concentrations of contaminants at and around the facility

2 2 1 Review of Available Data

Available sampling data will be reviewed to determine whether additional data need to be collected to thoroughly characterize the concentrations and physical distribution of installation/site-related contaminants General recommendations will be made for the collection of additional samples, if warranted

Technical Elements

- Review all available sampling data and associated quality assurance/quality control information for the installation/sites

- Determine data adequacy with regard to locations sampled, number of samples taken, and parameters analyzed

- Propose recommendations for additional sampling and analysis

2 2 2 Contamination Description

A description of the contaminant concentration levels found in environmental media at and near the installation/sites will be presented Concentration contour maps will be provided where applicable and will be in a format directly comparable to other pathways data The technical elements of this task will involve the preparation of a "Contamination Description" worksheet

Technical Elements

- Identify the chemical contaminants present on the installation/sites

  - Acquire, compile, and process available data to describe chemicals that represent potential contaminants

- Determine the extent of chemical contamination

- For each of the listed chemicals, determine the ranges of concentrations in the affected media, and the geographic area in which they are distributed

- When possible, compare monitoring data to background concentrations Eliminate chemicals that do not exceed background from the list

- Determine how the substances are distributed in the environment

  - For each of the listed chemicals, identify the media (air, water, soil, groundwater) affected

2 2 3 Identification of "Contaminants of Concern"

"Contaminants of Concern," also known as "indicator chemicals," represent the site-related contaminants that pose the greatest hazard to human health or to the environment They will be selected according to their (1) intrinsic toxicity, (2) magnitude (concentration and/or quantity) of contamination, (3) mobility in the environment, and (4) environmental persistence

Technical Elements

- For nonradioactive contaminants, the contaminants of concern will be selected using guidelines described in the Superfund Public Health Evaluation manual (U S EPA 1985) These steps include, but are not limited to, the following activities

  1) Calculation of indicator scores (based on concentration and toxicity) for nonradioactive chemicals

  2) Initial selection of nonradioactive indicator chemicals based on indicator scores

  3) Final selection of indicator chemicals based on consideration of other factors, including relevant chemical properties (e g , water solubility, vapor pressure, organic carbon partition coefficient, and persistence)

  - All radioactive substances measured at levels above natural background will be considered contaminants of concern

2.3 ENVIRONMENTAL FATE AND TRANSPORT ASSESSMENT

This assessment describes the potential for offsite migration of contaminants and provides estimates of the direction and rate of movement of contaminants in various environmental media The assessment will include information on site-specific environmental factors that may significantly affect the environmental fate and transport of contaminants Profiles of environmental fate and transport processes will be developed for each of the contaminants of concern

Objective Describe the fate and transport mechanisms that may affect the migration of contaminants from the installation/sites

2 3 1 Description of Environmental Setting

A description of the environmental setting for the installation/sites, including important geologic, hydrologic, and atmospheric data will be presented Potential migration pathways for the installation/sites will be discussed These data will be thoroughly discussed and presented in a form that will facilitate evaluating remedial alternatives

Technical Elements

- topography and surface water
- geology and groundwater
- meteorology/climatology
- biological regime
- migration pathways (listed below)
    - soil ---> groundwater (alluvium and valley fill materials, Arapahoe formation),
    - soil ---> groundwater (alluvium and valley fill) ---> surface waters (Woman Creek, Walnut Creek)
    - soil ---> groundwater ---> surface water ---> air
    - soil ---> surface water
    - soil ---> surface water ---> air
    - soil ---> air

2 3 2. Contaminant Release Analysis

Contaminant release analysis will involve the identification of potential and actual onsite sources of release for each of the contaminants of concern listed for the installation/sites Estimates of the magnitude of potential release rates will be made

Technical Elements

- Identify potential sources of release for each contaminant of concern

  1) The contaminant concentrations in each of the affected media will be summarized

  2) Actual/potential release pathways will be identified for each source Releases to the following media through the listed mechanisms will be considered

     - Air
       - generation of fugitive dusts (airborne wastes and contaminated soil particles)
       - volatilization
     - Surface water
       - groundwater discharge
       - runoff
     - Groundwater
       - leaching from contaminated soils
     - Soil
       - impoundment failure
       - runoff
       - spills
     - Biota
       - terrestrial/aquatic bioconcentration from direct uptake (ingestion) and from indirect uptake (absorption)

- Determine the likely contribution of each source of contaminant release to total contaminant release Release to each medium will be evaluated and quantified to the greatest extent possible, based on the following

  - contaminant concentrations
  - physical and chemical properties of the contaminants
  - climatological site parameters
  - hydrogeological site parameters

2.3 3 Environmental Fate and Transport Analysis

Technical Elements

(1) Determine the relative importance of environmental fate processes for each contaminant of concern in each potential migration medium

  (a) Inter-media physical fate processes to be considered include, but are not limited to,

    - Sorption
      - soils
      - sediments
      - suspended particulates (surface water, groundwater)
    - Volatilization
    - Infiltration
    - Bioaccumulation

  (b) Inter-media chemical fate processes to be considered include, but are not limited to,

    - Photolysis
    - Hydrolysis
    - Oxidation
    - Biodegradation
    - Rates of decay (radioactive substances)

(2) Quantify environmental fate and transport processes

  (a) Where possible use average release rate estimates derived during the contaminant release analysis to generate estimates of the direction of movement of contaminants and estimates of expected concentration of contaminants in various environmental media

  (b) Report any monitoring data to provide conservative estimates of final concentrations and the serial extent of contaminant migration

(3) Determine if a need exists for "fate and effect" modeling (e g , solute transport for groundwater and surface water, virtual point source for air)

(4) Results will be provided in a tabular as well as graphic format that will allow comparison to previously derived information

2.4. EXPOSURE ASSESSMENT

The purpose of the exposure assessment is to identify the actual or potential routes of exposure, characterize the population exposed, and determine the extent of exposure Information on expected doses received by a population will include a summary of the potential total dose received as a result of exposure

Objective. Evaluate the actual and potential exposure levels to contaminants of concern from the installation/sites

The following references will be used to derive estimates of exposure levels and dose

a) *Short Course on Integration of Exposure and Risk Assessment*, Part 3 Exposure Assessment Methods (Schaum 1984)

b) *Development of Statistical Distributions or Ranges of Standard Factors used in Exposure Assessments* (Anderson et al 1984)

The uncertainty associated with the exposure values is a function of the input parameters used throughout the exposure assessment process As a result, all exposure calculations for the risk assessment will be adequately documented Assumptions made in support of these calculations require justification, which will be included as part of the assessment document

2 4 1 Identification of Exposed and Potentially Exposed Populations

Technical Elements

- Compare data on the distribution of environmental contamination with population data

- Characterize the human, animal, and plant populations that may be exposed to the contaminants of concern for all potential migration pathways

- Develop the most recent census tract information regarding population distibution

- Obtain any available information regarding land development plans in the area from local agencies/developers to determine not only projected land and water use plans, but also future populations that may be at risk

2 4 2 Characterization of Exposed Populations

Technical Elements

- Those groups within the exposed or potentially exposed populations that may experience a greater risk than the average populations will be identified

2 4 3 Determination of Population Exposure Levels

Technical Elements

- Examine activities of potentially or actually exposed population to determine level of exposure in employment and recreation

2 4 4 Development of Exposure Coefficients

Technical Elements

- Where possible, evaluate information on frequency and magnitude of contact with contaminants to yield a quantitative value of the amount of contaminated medium contacted per day for each exposure route

A list of exposure coefficients is provided in *Superfund Exposure Assessment Manual* (Schultz et al 1984)

2 4 5 Determination of Population Dosage Levels

Technical Elements

- The results of the Contaminant Release Analysis, Environmental Fate Analysis, and Exposed Population Analysis will be integrated to determine the cumulative dose of each contaminant incurred by the exposed population

- For each target population "worst case" and "most probable case" estimates will be made of the total daily exposure/dosage to each contaminant of concern

  1) Frequency and magnitude of contact with contaminants through each exposure route will be evaluated, e g, average daily intake of drinking water, grams of fish consumed/day, volume of air inhaled/day

  2) Rates of absorption will be characterized to the greatest extent possible for each contaminant of concern through each exposure route

  3) Dosages will be determined for each exposure route on the basis of predicted exposure levels, frequency of contact, and absorption factors

  4) Total dosages of each contaminant of concern will be calculated by adding dosages through all exposure routes

2 5 TOXICITY ASSESSMENT

The toxicity assessment will present a characterization of the key toxicological properties of each of the contaminants of concern The characterization will identify indices of toxicity, acceptable daily intakes, and estimates of unit cancer risk where this information is available

Objective Characterize the toxicities to human health and the environment associated with exposure to the contaminants of concern

A toxicity profile for each contaminant of concern will be derived from current toxicological literature and will involve a critical evaluation and interpretation of all relevant data The profile will include a consideration of doses used, routes of exposure, types of adverse effects manifested, and quantitative indices of toxicity

Information concerning chemical, physical, and toxicological properties will be gathered from standard references and government documents If necessary, a computer search will be performed to obtain additional information

2 5 1 Literature Search

Technical Elements

- Potential sources of information include (but will not be limited to) the following EPA documents/references

Criteria Document - Ambient Water Quality	Office of Water Regulations and Standards
Criteria Document - Air	Office of Air Quality Planning Standards (OAQPS)
Criteria Document - Drinking Water	Office of Drinking Water (ODM)
Chemical Hazard Information Profile (CHIP)	Office of Toxic Substances (OTS)
Chemical Profile	Office of Waste Programs Enforcement (OWPE)
Health Assessment Document	Office of Health and Environmental Assessment (OHEA)
Health Effects Assessments	Office of Emergency and Remedial Responses (OERR)
Proposed Guidance on Dose Limits for Persons Exposed to Transuranium Elements in the General Environment	Office of Radiation Programs
Quality Criteria for Water 1986	Office of Water, Planning and Standards

- Non-EPA references that will be considered for review will include (but not be limited to)

  - American Conference of Government Industrial Hygienists (ACGIH), 1985

  - Threshold Limit Values and Biological Exposure Indices for 1986-1987

- G D Clayton and F E Clayton, eds *Patty's Industrial Hygiene and Toxicology* (John Wiley & Sons, New York, 1981)

- I N Sax, *Dangerous Properties of Industrial Materials*, 6th ed (Van Nostrand Reinhold Company, New York, 1984)

- United States Department of Health and Human Services Registry of Toxic Effects of Chemical Substances DHHS (NIOS) Publication No 80-111 (1980)

- K Verschueren, *Handbook of Environmental Data on Organic Chemicals*, 2nd ed (Van Nostrand Reinhold Co, New York, 1983)

  - Computerized literature files that may prove valuable include

    CHEMLINE
    CHEMTREC
    MEDLINE
    OHM-TADS
    RTECS
    TOXLINE

2 5 2 Prepare a Health Toxicity Profile for Each Contaminant of Concern

Technical Elements

- Summarize data from animal studies, emphasizing dose-response relationships Information will cover

  a) dose levels

  - acute, subchronic, chronic effects
  - no-observable adverse effect level or lowest observable adverse effect level

  b) routes of exposure

  - ingestion
  - inhalation
  - dermal absorption

  c) biological end points

  - carcinogenecity
  - mutagenicity
  - teratogenicity
  - neutrotoxicity
  - behavioral toxicity

- immunosuppression

- Summarize data from human epidemiological studies or case histories (see above list)

- List quantitative indicators of toxicity, including regulatory standards

  1) Drinking water standards

  2) Ambient air quality standards

  3) Acceptable daily intakes (ingestion, inhalation, chronic, and subchronic)

2 5 3 <u>Prepare an Environmental Toxicity Profile for Each Contaminant of Concern</u>

<u>Technical Elements</u>

- Summarize toxic effects on terrestrial and aquatic animal/plant life, emphasizing dose-response relationships Information will cover lethality, organotoxicity, behavioral effects, and reproductive effects

- List applicable regulatory standards for ambient water quality criteria and irrigation criteria

2 6. RISK CHARACTERIZATION

The purpose of this evaluation is to integrate the findings of the exposure and toxicity assessments to estimate site-specific risks The characterization describes potential adverse effects and estimates risk to public health and the environment based on existing guidelines and standards (e g , drinking water standards, water quality criteria, and ambient air quality standards)

The level of detail provided for each of the technical components depends on whether the available data are sufficient to perform individual assessments All assumptions made in the performance of an assessment will be clearly defined

<u>Objective</u> Determine whether actual or potential health or environmental risks are posed by the exposure conditions described in the exposure assessment for the installation sites

The risk characterization integrates the information developed during the environmental fate and transport, exposure, and toxicity assessments to determine whether unacceptable risks are posed by the contaminant of concern for each site A four-task approach will be undertaken to achieve this goal

1) Characterization of carcinogenic risk
2) Characterization of noncarcinogenic risk
3) Characterization of environmental risk
4) Characterization of public welfare risk

For each task, risk will be determined for both "worst case" and "most probable" situations Current risk will be evaluated on the basis of recent sampling data collected at predicted exposure points Potential future risk will be determined on the basis of projected exposure concentrations predicted by modeling

2 6 1 Characterization of Carcinogenic Risk

Technical Elements

- Compare site-specific exposure levels to regulatory guidelines and standards

- For each exposed human population, calculate (when possible) the carcinogenic risk posed by each known/suspect carcinogen

- Calculate total carcinogenic risk for all carcinogens by adding individual risks

- If no criterion is available for a contaminant, compare exposure concentrations to available dose-response information

- Characterize uncertainties associated with risk estimates

2 6 2 Characterization of Noncarcinogenic Risk

Technical Elements

- For each exposed human population, compare exposure/dosage levels of each contaminant of concern to acceptable levels (e g, acceptable daily intakes), regulatory guidelines and standards and/or other health criteria,

- Calculate chronic/subchronic hazard index as described in the *Superfund Public Health Evaluation Manual* (U S EPA, 1986)

- If no criterion is available for a contaminant, compare exposure concentrations to available dose-response information

- Characterize uncertainties associated with risk estimates

2 6 3 Characterization of Environmental Risk

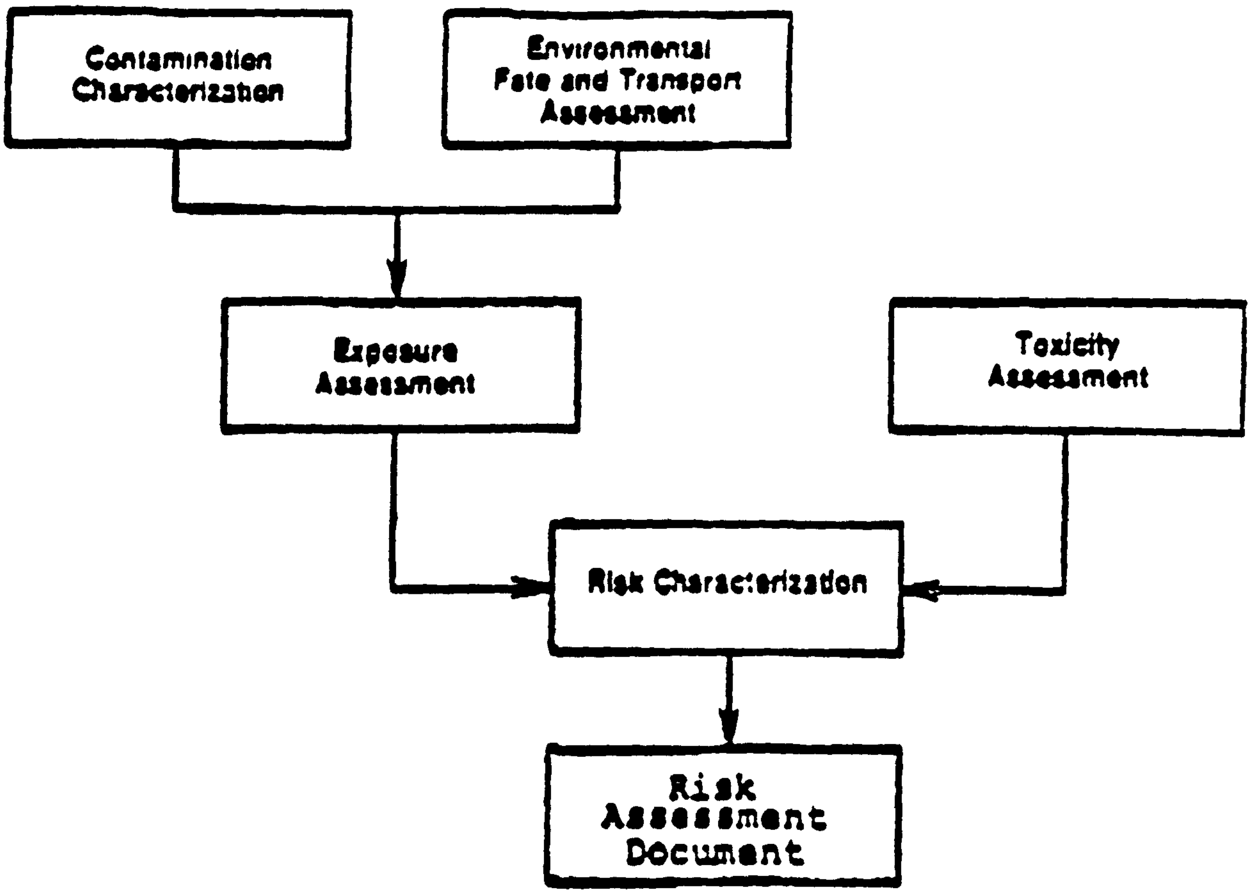
Technical Elements

- Compare estimated environmental concentrations of contaminants of concern to regulatory guidelines and standards

- If regulatory guidelines are not available, evaluate potential risk to plants and animals on the basis of available ecotoxicity information

- Evaluate risk to endangered or threatened species or critical habitats in direct or indirect contact with contaminants

- Characterize uncertainties associated with risk estimates



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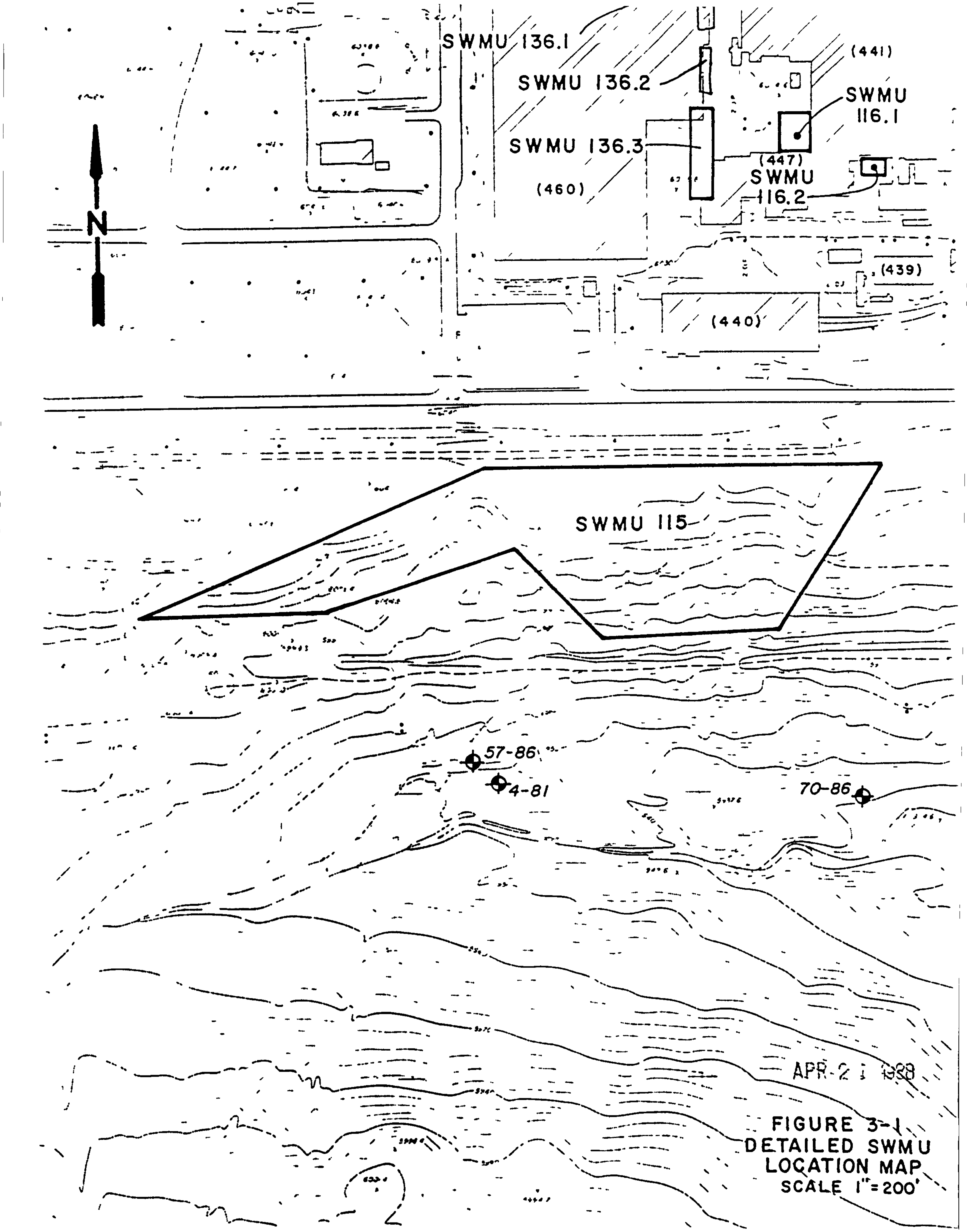

FIGURE 3-1
DETAILED SWMU
LOCATION MAP
SCALE 1"=200'

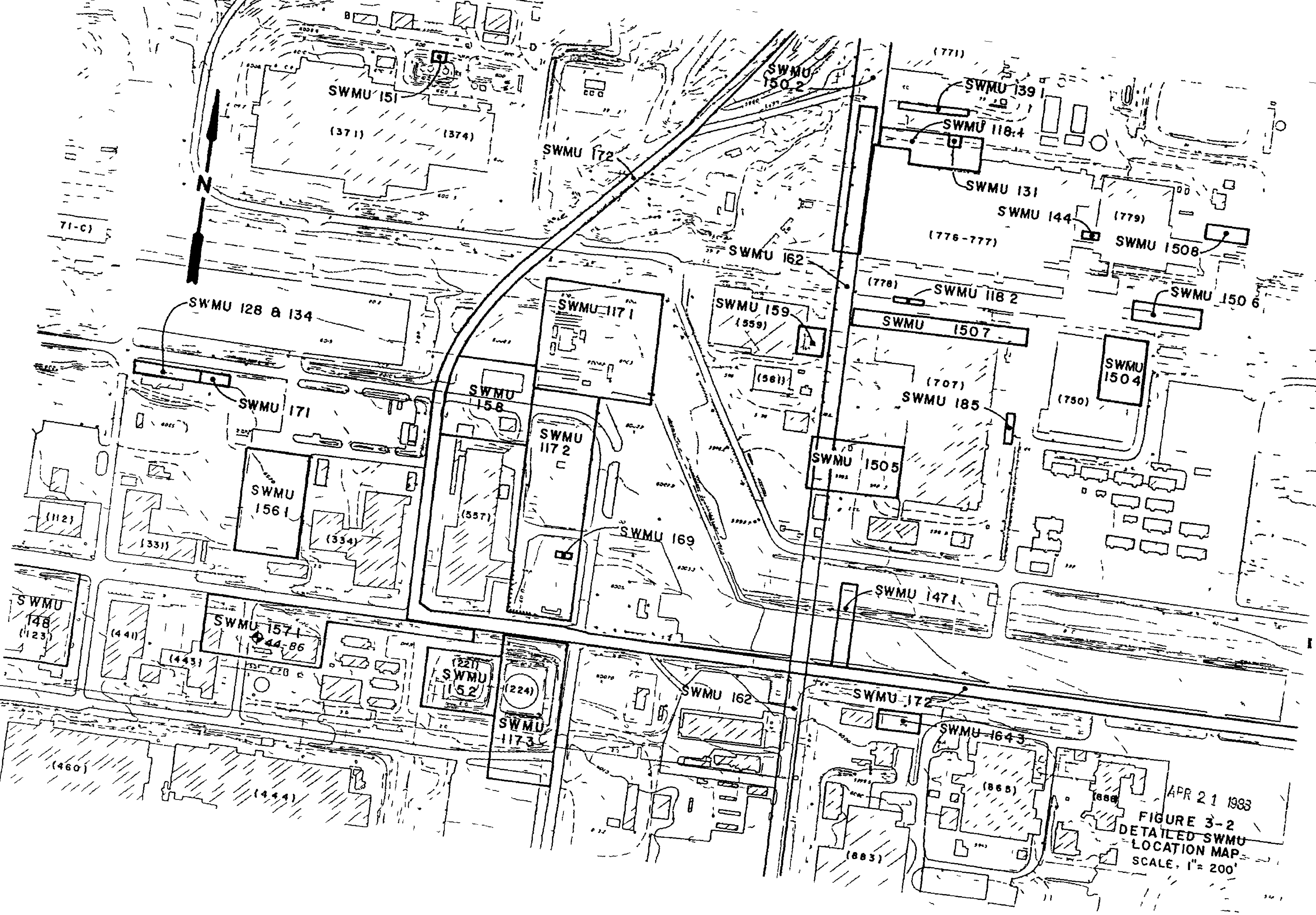

FIGURE 3-2
DETAILED SWMU
LOCATION MAP
SCALE, 1" = 200'

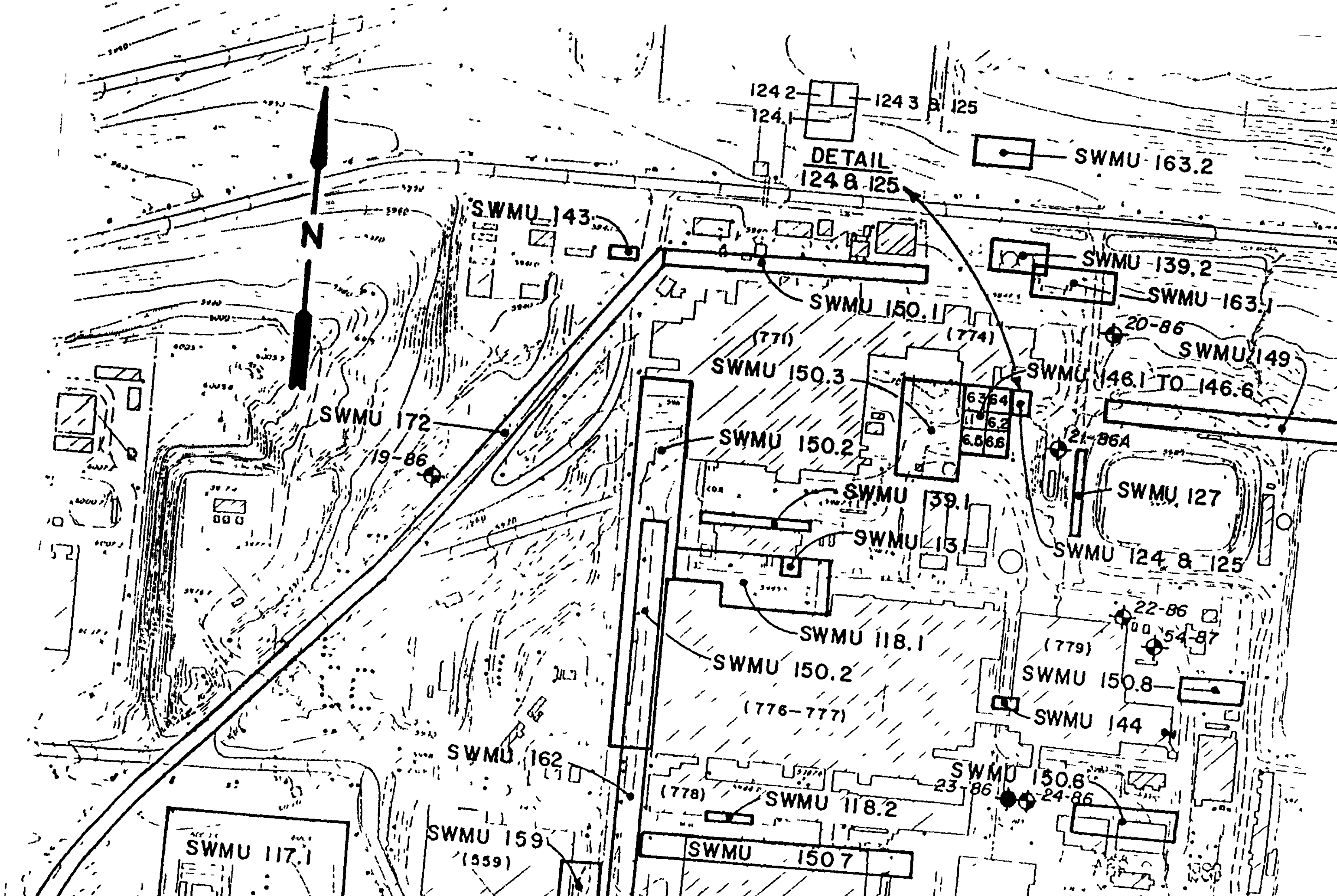

FIGURE 3-3
DETAILED SWMU LOCATION MAP
SCALE 1" = 200'

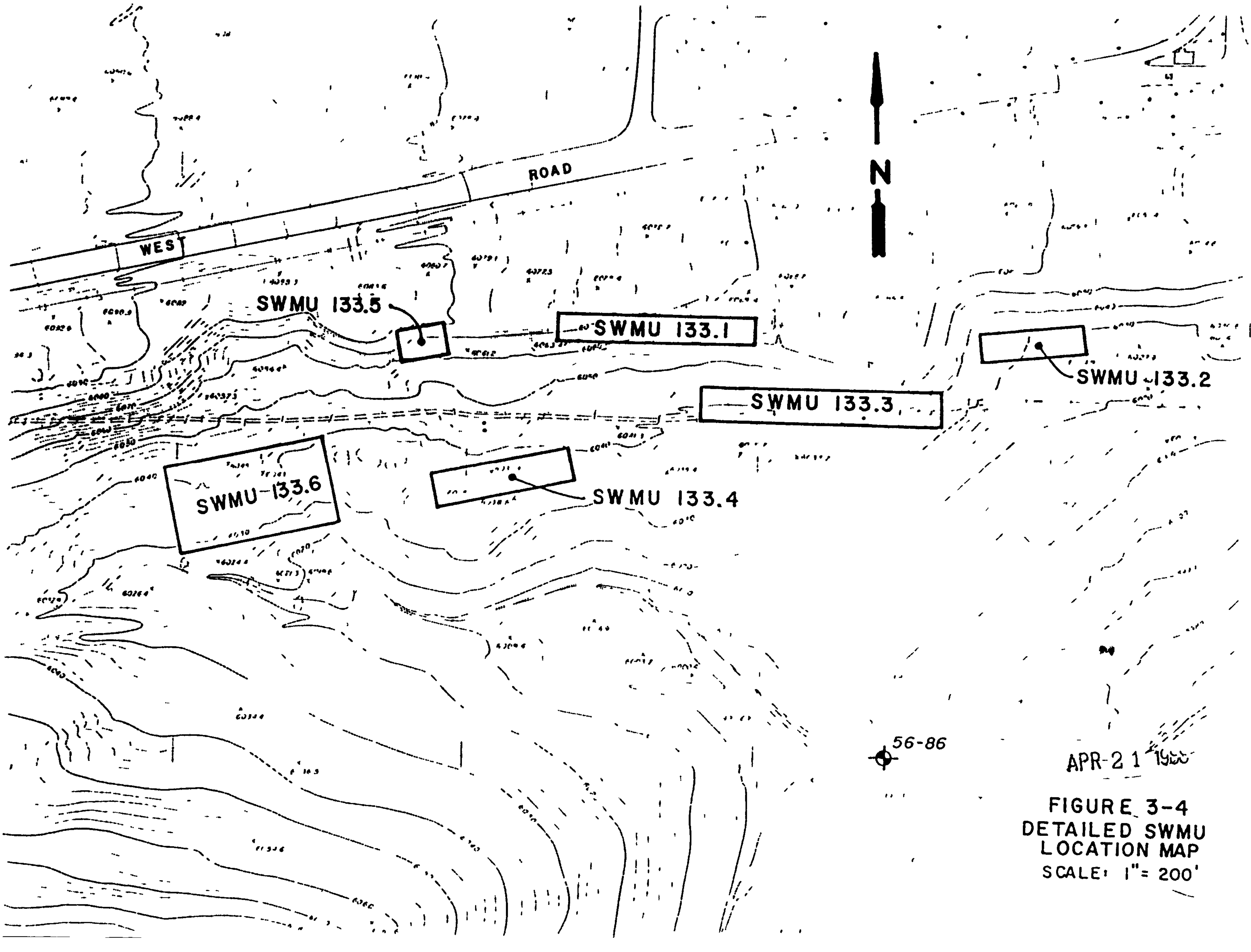

FIGURE 3-4
DETAILED SWMU
LOCATION MAP
SCALE: 1" = 200'

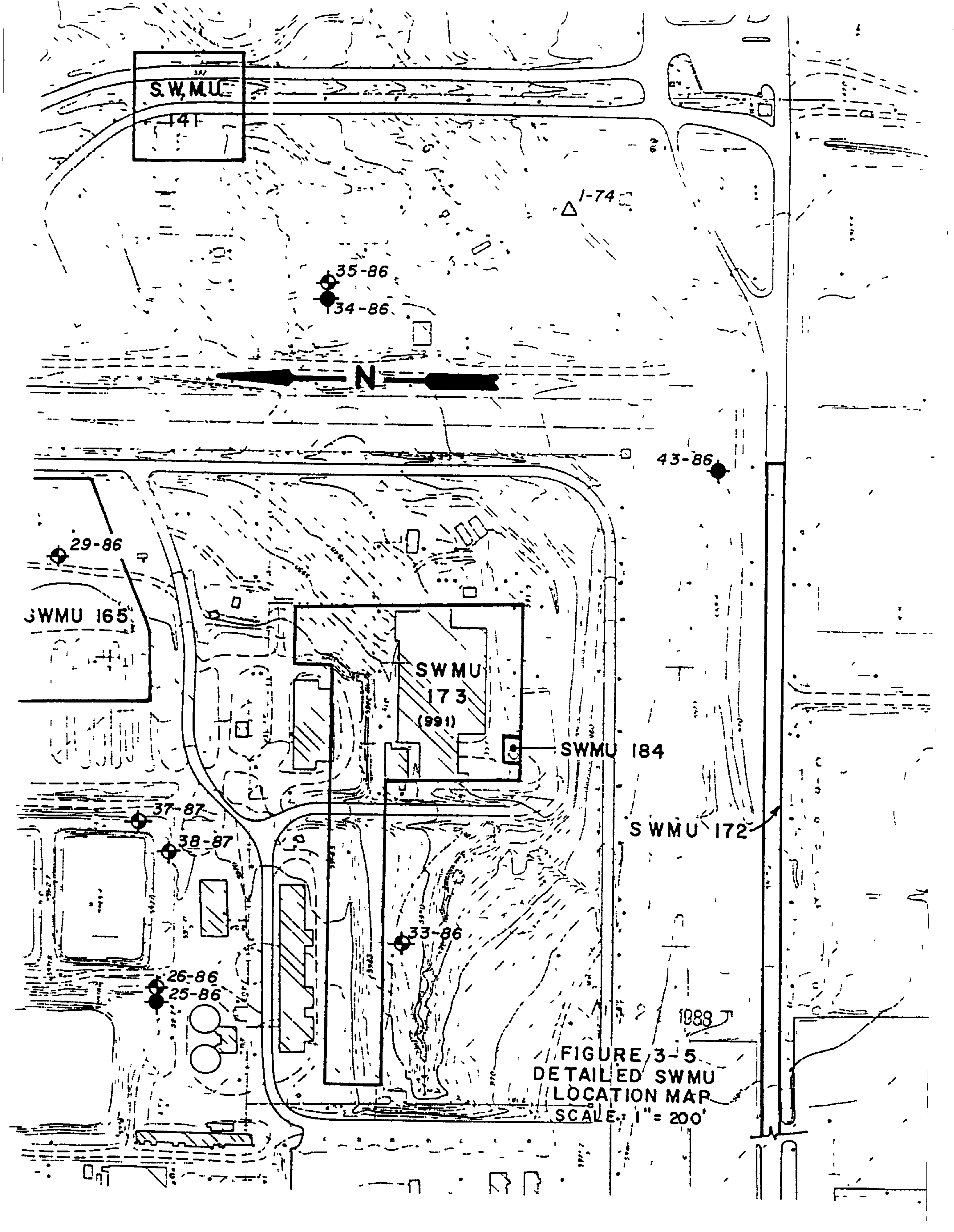

FIGURE 3-5
DETAILED SWMU
LOCATION MAP
SCALE: 1" = 200'

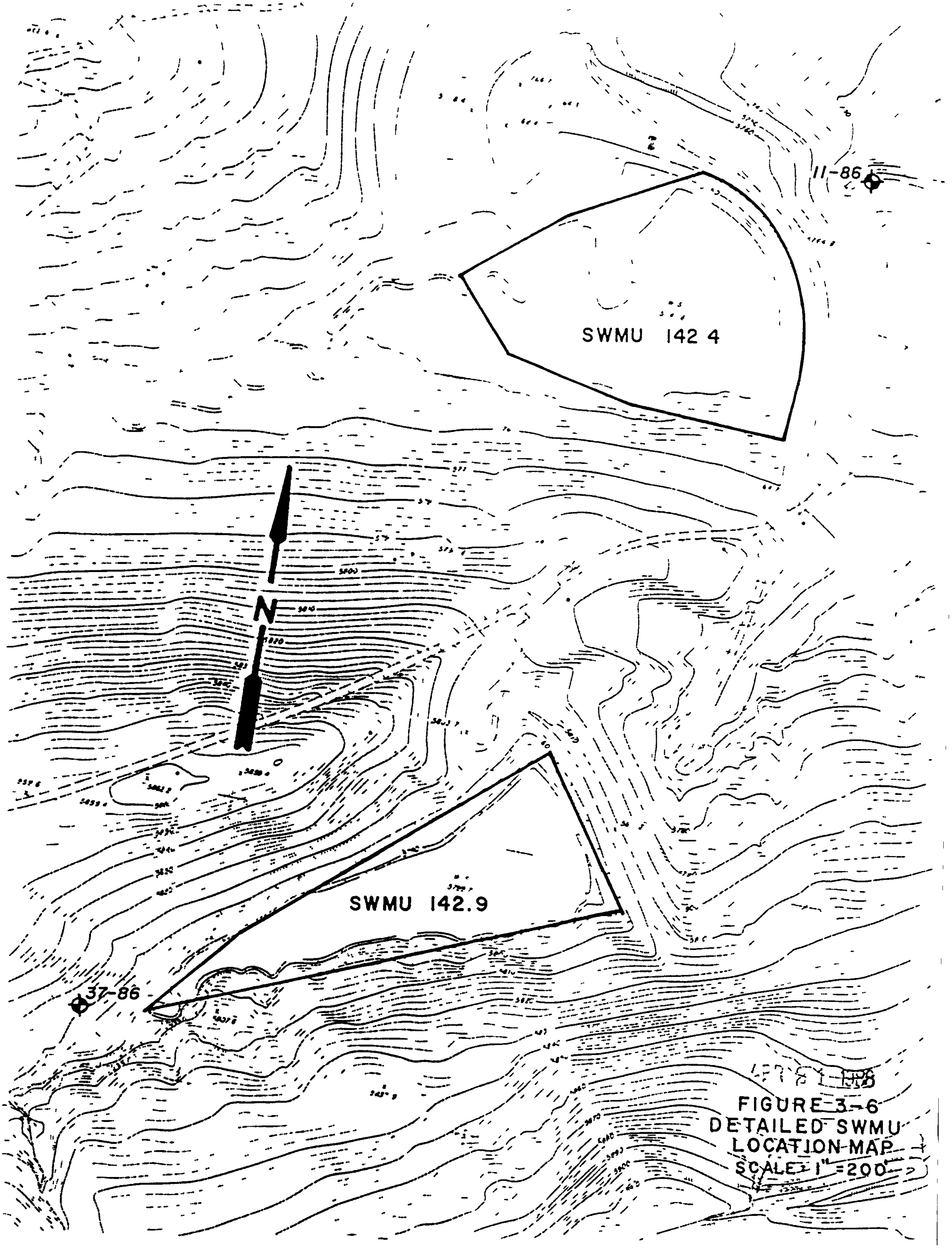

FIGURE 3-6
DETAILED SWMU
LOCATION MAP
SCALE: 1" = 200'

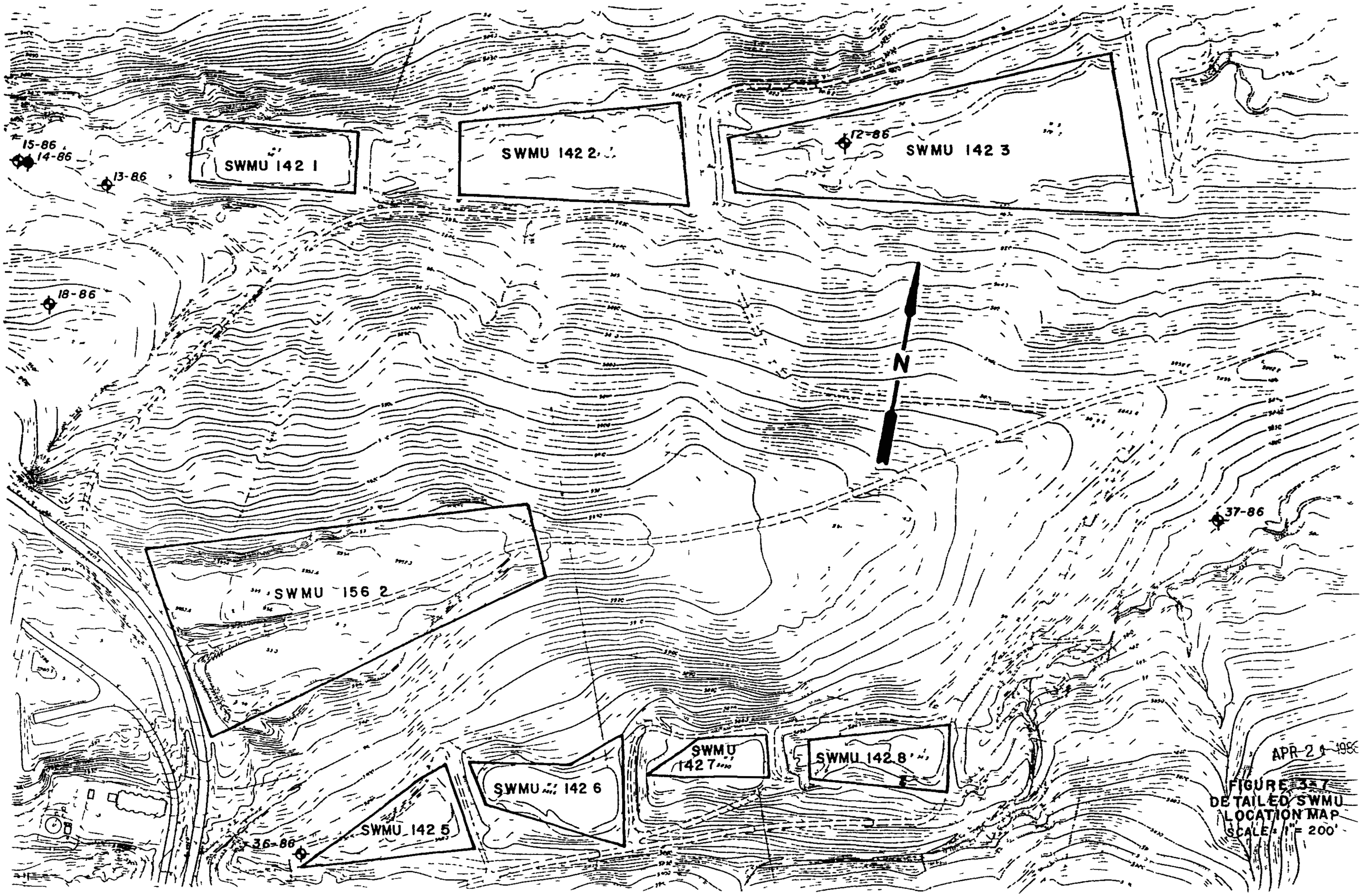

FIGURE 3-7
DETAILED SWMU
LOCATION MAP
SCALE: 1" = 200'

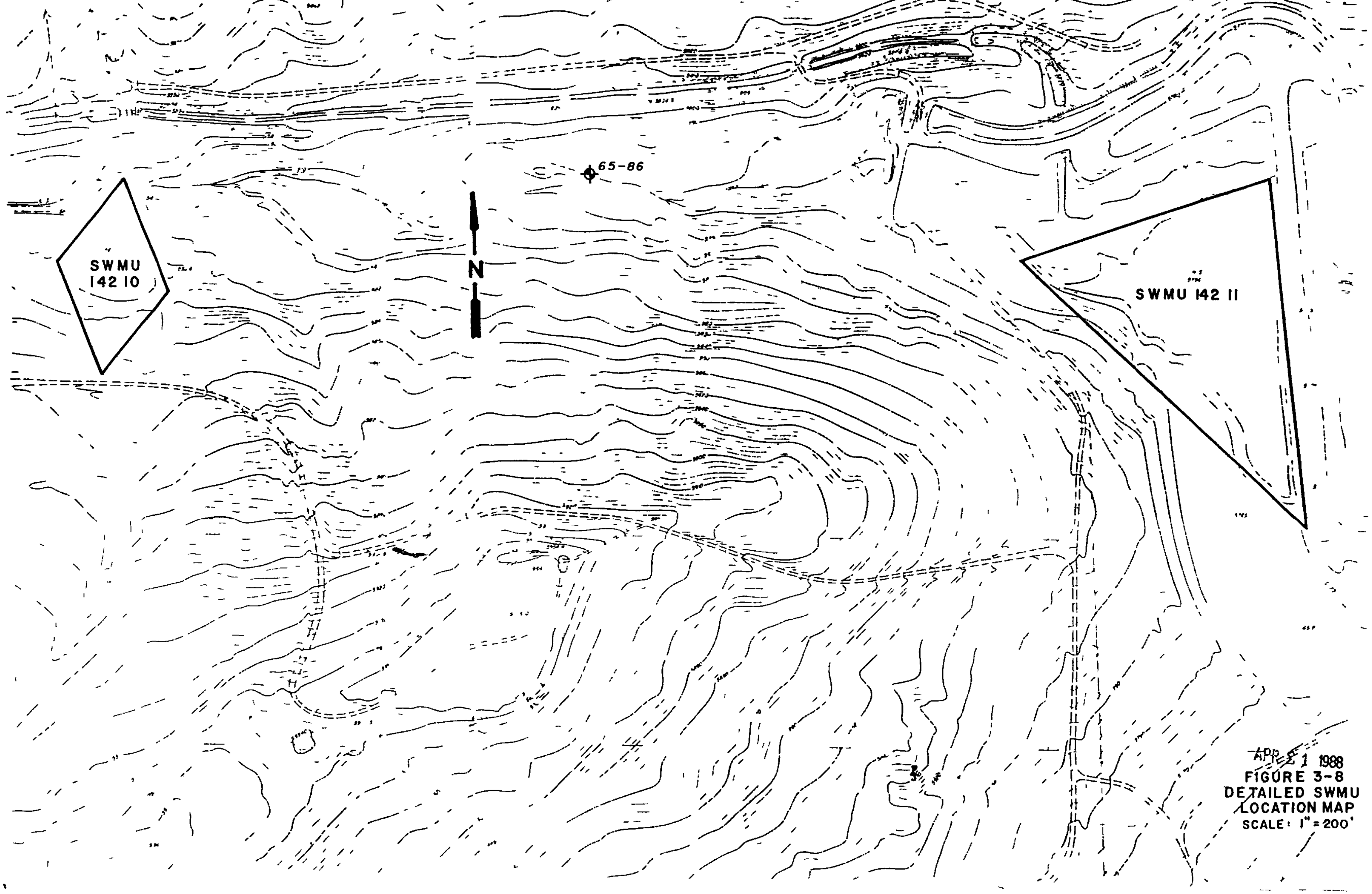

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FIGURE 3-8
DETAILED SWMU
LOCATION MAP
SCALE: 1" = 200'

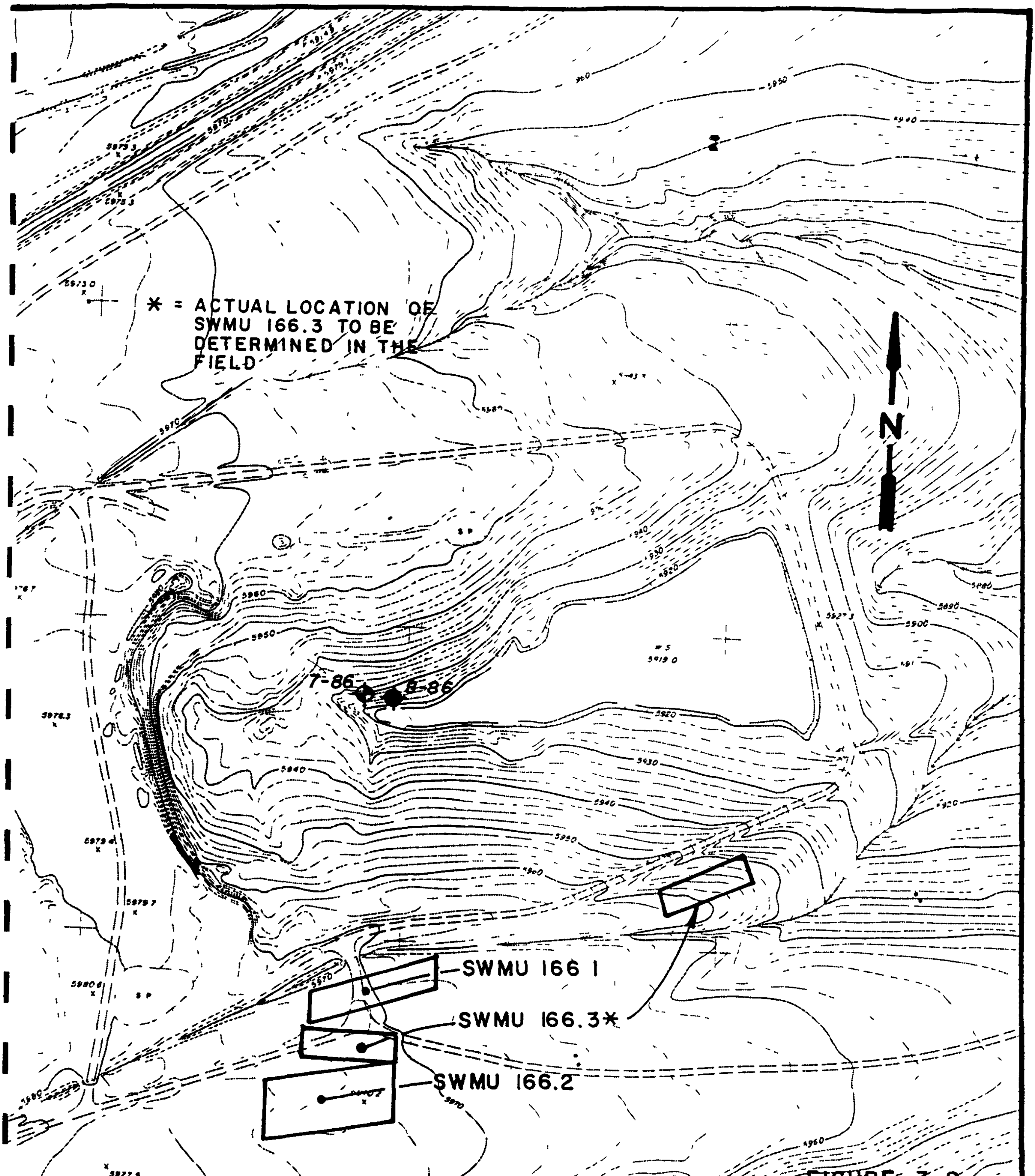

FIGURE 3-9
DETAILED SWMU LOCATION MAP
SCALE 1" = 200'

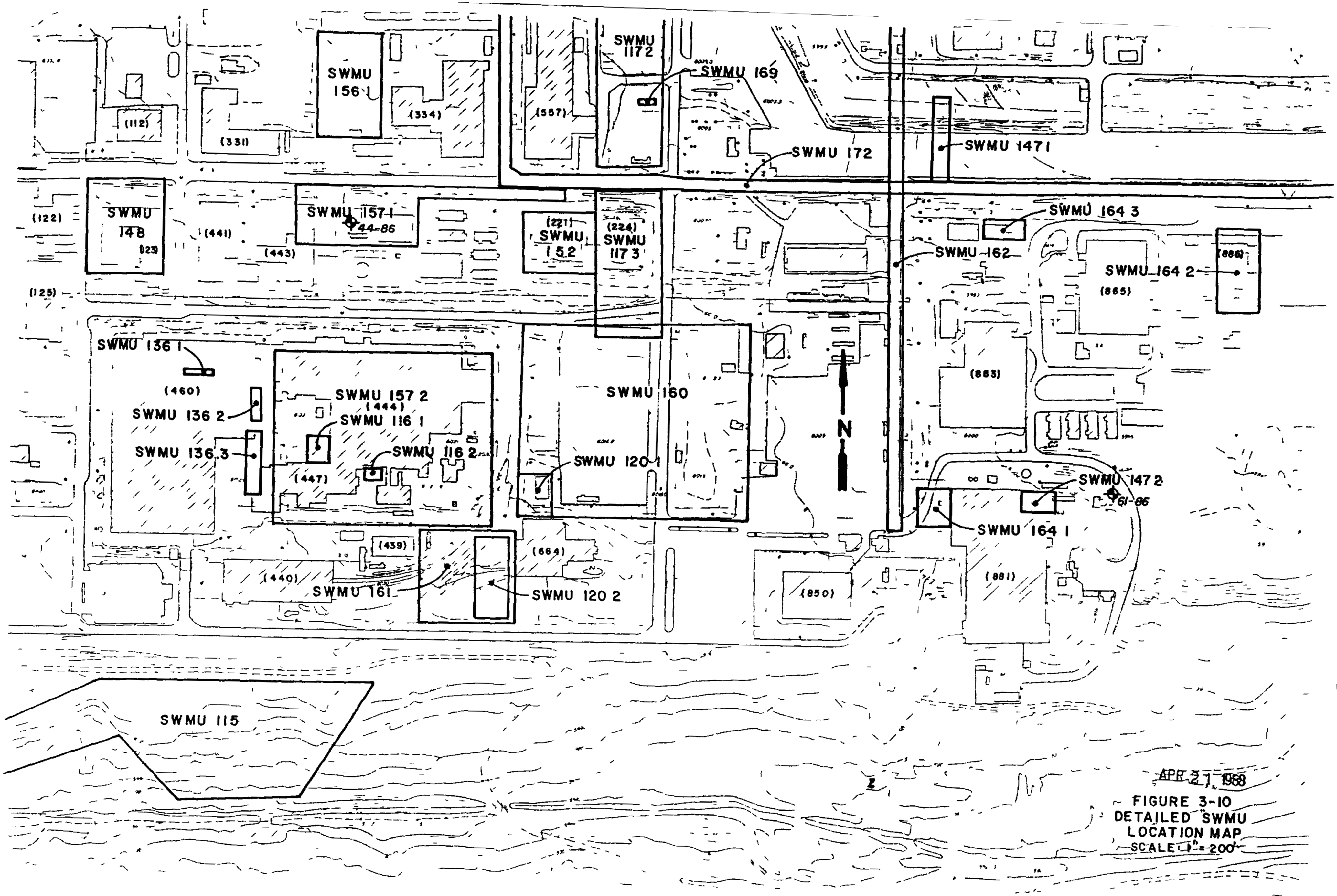

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FIGURE 3-10
DETAILED SWMU
LOCATION MAP
SCALE 1" = 200'

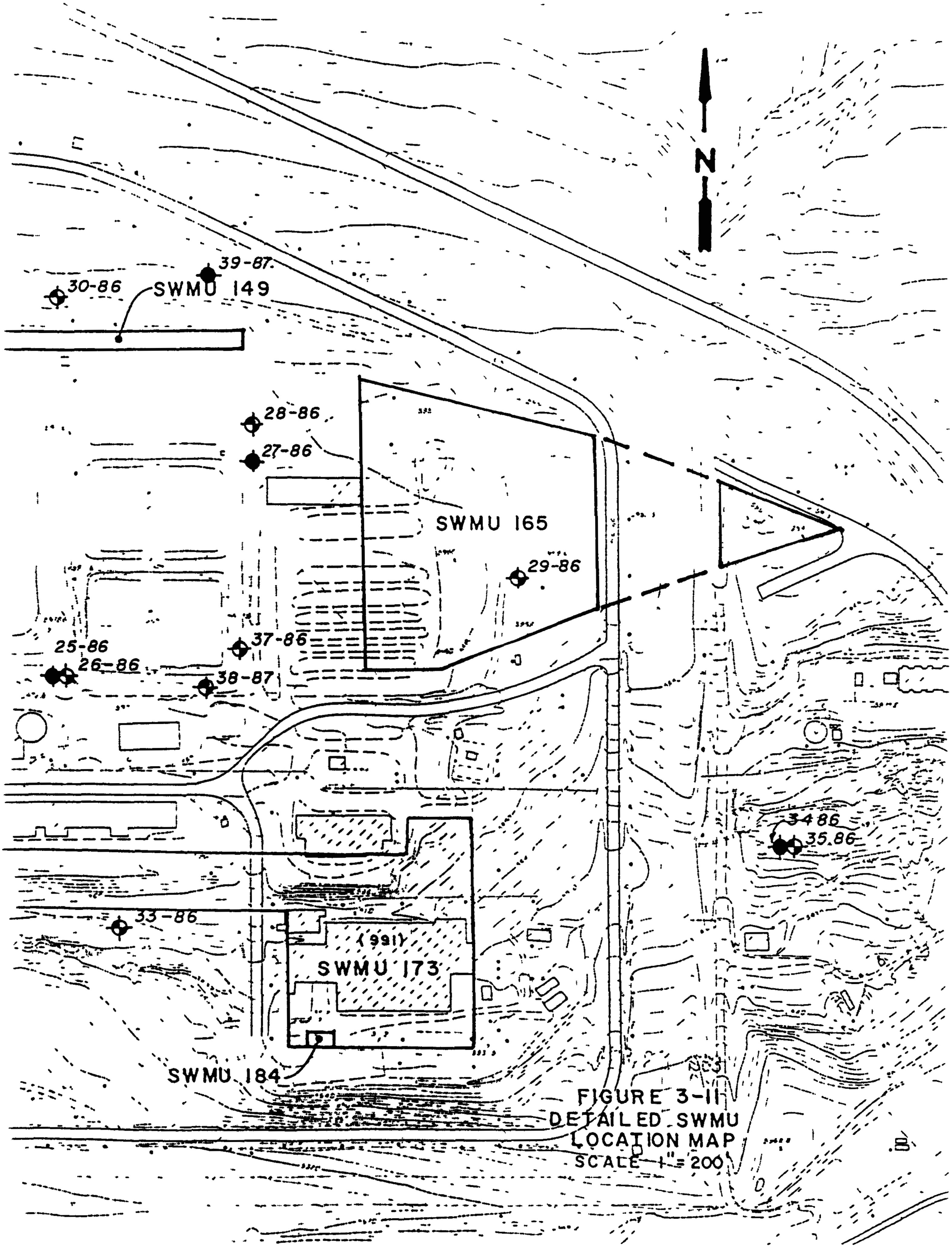

FIGURE 3-11
DETAILED SWMU
LOCATION MAP
SCALE 1" = 200'

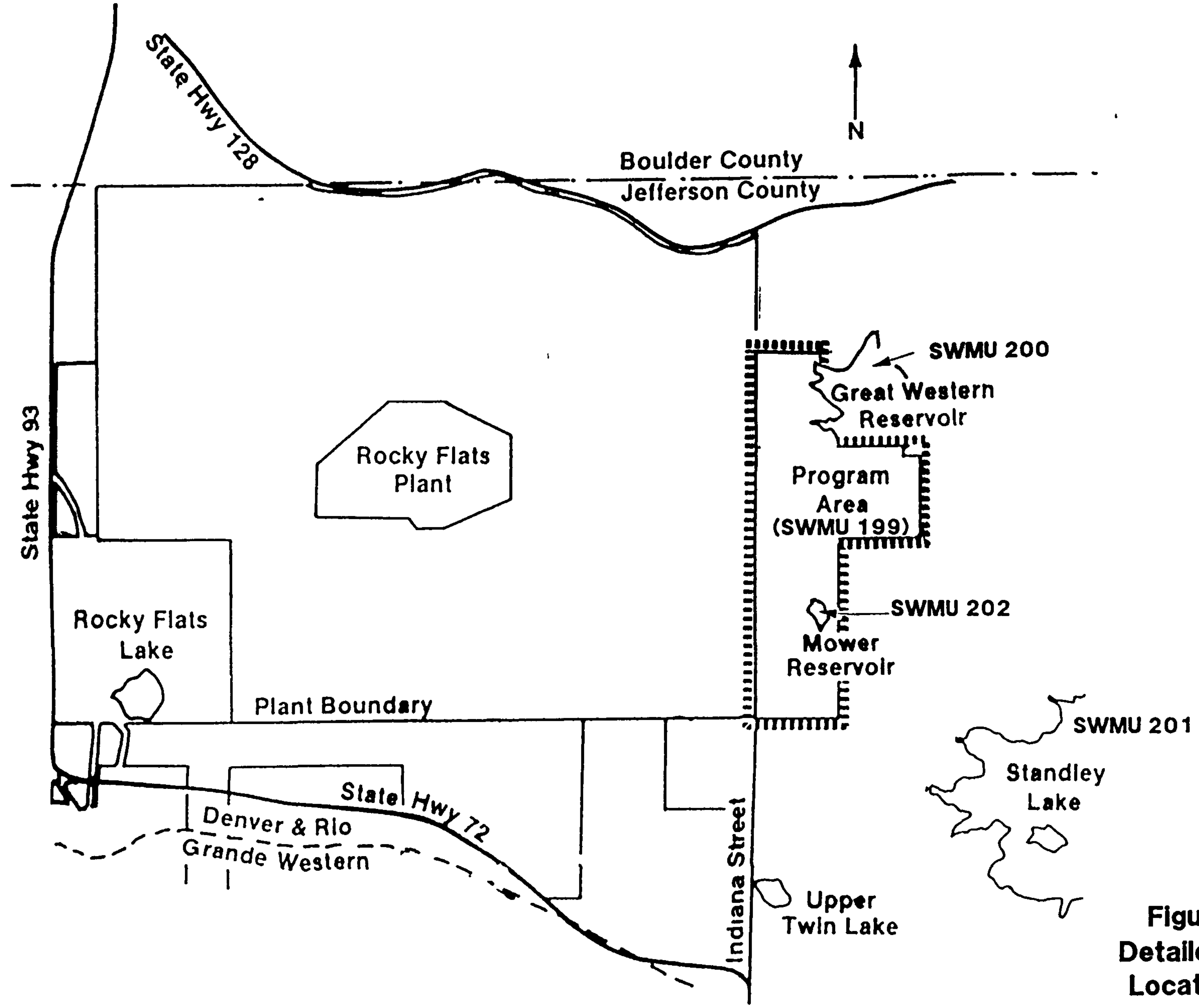

Figure 3-12
Detailed SWMU
Location Map